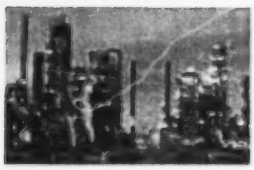
CCME

Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

NATIONAL FRAMEWORK FOR PETROLEUM REFINERY EMISSION REDUCTIONS



# NATIONAL FRAMEWORK

## FOR PETROLEUM REFINERY EMISSION REDUCTIONS

PN 1338

105-05660/

## About CCME

The Canadian Council of Ministers of the Environment (CCME) is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international and global concern. The 14 member governments work as partners in developing nationally consistent environmental standards, practices and legislation.

Canadian Council of Ministers of the Environment
123 Main St., Suite 360
Winnipeg, Manitoba R3C 1A3
Ph: (204) 948-2090 Fax: (204) 948-2125
www.ccme.ca

Disponible aussi en français sous le titre : *Cadre national pour la réduction des émissions des raffineries de pétrole*. PN 1339

## Disclaimer

This publication includes summary results of a study conducted by Levelton Engineering Ltd. under contract to the Canadian Council of Ministers of the Environment (CCME). CCME is committed to reflect the highest standards of research and analysis in its publications. CCME is not responsible for the accuracy of the data contained in the study and does not warrant, or necessarily share or affirm, in any way, any opinions expressed therein.

PN 1338
ISBN 1-896997-56-2

© Canadian Council of Ministers of the Environment Inc., 2005

# Table of Contents


1. **Introduction** . . . . . 1
   - 1.1 Goals . . . . . 1
   - 1.2 Expected Outcomes . . . . . 2
2. **Development of the National Framework** . . . . . 2
   - 2.1 The Process . . . . . 2
   - 2.2 Consultation . . . . . 3
3. **Applicability** . . . . . 4
   - 3.1 Scope of Application . . . . . 4
   - 3.2 Air Pollutants . . . . . 4
4. **The Elements of the National Framework for Petroleum Refinery Emission Reductions** . . . . . 5
   - 4.1 Element 1 – Methodology . . . . . 7
     - 4.1.1 Benchmarking . . . . . 7
     - 4.1.2 Health Prioritization . . . . . 7
     - 4.1.3 Illustrative Guide . . . . . 8
     - 4.1.4 Setting and Prioritizing Caps . . . . . 8
     - 4.1.5 Keeping the Methodology Current . . . . . 9
   - 4.2 Element 2 – Emission Monitoring and Reporting Strategy . . . . . 9
   - 4.3 Element 3 – Ten Year Plan . . . . . 11
     - 4.3.1 Performance Measurement . . . . . 12
     - 4.3.2 Updating of the National Framework Tools and Analysis . . 13
     - 4.3.3 Reporting on Progress . . . . . 14
     - 4.3.4 Assessment of the Framework . . . . . 15
     - 4.3.5 Roles and Responsibilities . . . . . 16
     - 4.3.6 Schedule . . . . . 16
   - 4.4 Element 4 – Jurisdictional Management . . . . . 17
     - 4.4.1 Determining Refinery Emission Management Actions . . . . 17
     - 4.4.2 Intensity Basis . . . . . 18
     - 4.4.3 Timing Issues . . . . . 19
     - 4.4.4 Instruments for Implementation . . . . . 19
5. **Looking Ahead** . . . . . 19
6. **Alternative Views** . . . . . 19
7. **List of Acronyms and Abbreviations Used** . . . . . 21
8. **Glossary of Terms** . . . . . 21

**Appendix A:**

**Terms of Reference for Development of a Canadian Council of Ministers of the Environment (CCME) National Framework for Petroleum Refinery Emission Reductions ..... A-1**

**Appendix B:**

**Membership in the NFPRER Steering Committee and Sub-Groups ..... B-1**

**Appendix C:**

**Additional Sources of Information ..... C-1**

Benchmarking Studies and Reports ..... C-1
Health Studies and Reports ..... C-1
Monitoring and Reporting Studies and Reports ..... C-1
Communications and Consultation Reports ..... C-1

**Appendix D:**

**Methodology ..... D-1**

Benchmarking Analysis ..... D-1
Health Prioritization Analysis ..... D-14
Illustrative Guide ..... D-16

**Appendix E:**

**Emission Monitoring and Reporting Strategy ..... E-1**

Introduction ..... E-1
Scope ..... E-1
Refinery and Terminal Definitions ..... E-1
Principles of EM&R Strategy ..... E-2
Background ..... E-2
Elements of the Emission Monitoring and Reporting Strategy ..... E-3
1. Facility Emission Monitoring (Measurement and/or Estimation) ..... E-4
2. Facility Emission Reporting ..... E-8
3. Record Keeping for Facility Emission Monitoring and Reporting ..... E-9
4. Quality Assurance and Quality Control ..... E-10
   4.1 QA/QC for Facilities ..... E-10
   4.2 Data Quality Validation (QA/QC) for Provinces, Municipalities and Environment Canada ..... E-10
5. Ambient Monitoring and Reporting ..... E-11
6. Implementation ..... E-12

**Appendix F:**

**Ten Year Plan ..... F-1**

## 1. Introduction

The National Framework for Petroleum Refinery Emission Reductions (NFPRER) has been developed as a new approach to reduce emissions from the petroleum refining sector in Canada. The initiative began in 2001 when the Canadian Petroleum Products Institute[1] (CPPI) approached provincial and federal environment and energy departments with a proposal to establish a new way to regulate air emissions from Canadian petroleum refineries. The objective was to develop a new, more effective approach to reduce emissions at refineries, an approach which stimulates innovation but preserves or even enhances the competitiveness of the Canadian petroleum refining industry. The basis of the proposal was the development of a national framework, which would help municipal and provincial jurisdictions establish annual facility-wide emissions caps for a range of air pollutants from Canadian refineries. These caps would:

- set maximum emission levels for criteria air pollutants and air toxics, which would apply to the refinery as a whole, rather than to individual sources at the refinery; and
- be "performance based" rather than "prescriptive." That is, they would not dictate the technology refineries must use in order to achieve the required emission reductions.

The Terms of Reference for the development of the NFPRER are included in Appendix A. The NFPRER initiative is intended to lead to better air quality and help reduce negative health impacts, such as respiratory and chronic illnesses, that may be caused by criteria air contaminants and air toxics. Implementation of the National Framework is expected to lead to substantial reductions – as high as 50% of some parameters at some facilities. The Framework does not preclude jurisdictions from undertaking other actions that they deem necessary to protect human health and the environment. It is complementary to initiatives in place or under development within jurisdictions, and to national initiatives such as the Federal Agenda on Vehicles, Engines and Fuels and the Canada-wide Standards for Particulate Matter and Ozone.

### 1.1 Goals

The goals of the National Framework for Petroleum Refinery Emission Reductions are:

- protection of human health and the environment;
- achievement of real, quantifiable, verifiable emission reductions that will contribute to improved air quality, both locally and regionally; and
- convergence of the environmental performance (current and anticipated) of Canadian refineries with comparable U.S. refineries, in a manner that:
  - preserves the competitiveness of the petroleum refining sector in Canada; and
  - maintains any superior performance that already exists in Canada.

[1] The CPPI is a national association representing the majority of the petroleum products refining, distribution and marketing industry in Canada. The CPPI has its head office in Ottawa, with regional offices in Calgary, Toronto, Montréal and Halifax.

### 1.2 Expected Outcomes

- The National Framework for Petroleum Refinery Emission Reductions would be used by all jurisdictions that regulate air emissions from refineries.
- Regulatory and other actions would be implemented by provinces and/or municipalities to set facility-level annual caps for emissions of a range of air pollutants from Canadian petroleum refineries, including sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter (total, $PM_{2.5}$, $PM_{10}$) and benzene:
  - in a prioritized and phased manner over a ten year period; and
  - resulting in an improved level of health protection, as a result of improved environmental performance, at least on par with the current or anticipated performance of comparable U.S. refineries.

## 2. Development of the National Framework

### 2.1 The Process

A multi-stakeholder Steering Committee co-chaired by Environment Canada and Alberta Environment supervised the development of the NFPRER. The Steering Committee reports to the National Air Issues Coordinating Committee – Other Air Issues (NAICC-A), which in turn reports to the CCME Environmental Planning and Protection Committee (EPPC). Steering Committee members include federal, provincial and municipal governments, the Canadian Petroleum Products Institute, and non-governmental health and environmental organizations. A list of members of the Steering Committee and Sub-Groups is provided in Appendix B. The principles used to guide the development of the National Framework are listed in Box 1.

Under the guidance of the Steering Committee, a number of sub-groups were formed to work on specific aspects of the Framework. These groups have carried out a series of background studies to support the development of the NFPRER and provide the principles and methods for use by jurisdictions to establish and prioritize facility-level emissions caps for key air pollutants and air toxics from Canadian petroleum refineries. A list of these background studies and other sources of information is provided in Appendix C.

**Box 1: Principles Guiding the Development of the NFPRER**

The process to develop the National Framework for Petroleum Refinery Emission Reductions has been guided by the following principles:

- Proceed in a timely manner, to establish a framework including principles and methods to set facility caps within two years from the beginning of the process.
- Focus on flexible approaches that set limits on emission performance that lead to positive environmental and health outcomes, rather than prescribing specific technologies.
- Engage interested stakeholders in decision making in an open and transparent manner.
- Take into account wherever possible the monitoring and reporting requirements of existing and/or potential initiatives, such as emissions trading schemes, National Pollutant Release Inventory, etc.
- Take into account the time frame established by the Kyoto Protocol, as well as clean air initiatives such as Canada-wide standards.
- Provide a consistent level of environmental performance and health protection associated with petroleum refineries across Canada.
- Be consistent with jurisdictional approaches such as continuous improvement or keeping clean areas clean.
- Be consistent with the precautionary principle, as articulated in Rio Principle 15.

## 2.2 Consultation

Input on the Framework has been sought through public and stakeholder events, which varied in content from information-sharing to consultation.

A Discussion Document on the Framework was prepared and made available on the CCME website in early February 2004 and used as the basis for consultation. A two-day national workshop was held February 25–26, 2004, in Ottawa, Ontario.

Events were held in a number of communities where refineries are located, as listed below. Those sessions for which the Discussion Document was available are shown with an asterisk:

- Vancouver* – hosted by CPPI;
- Edmonton* – hosted by CPPI;
- Sarnia – for members of the Bluewater Community Advisory Panel;
- Montréal* – as an initiative of the CLIC (*Comité de Liaison de l'Industrie et de la Communauté, Association industrielle de l'est de Montréal*); and
- Lévis* – as an initiative of the *Comité permanent de liaison avec la communauté de la raffinerie Ultramar*.

Other community advisory panels, including the Irving Oil Community Liaison Committee, had processes to send a delegate to the national workshop and/or submit written comments on the Discussion Document.

Attendees at the national workshop, as well as other interested stakeholders, were encouraged to send written submissions outlining their views on the Discussion Document. The views expressed at the national workshop, as well as written submissions, were considered in finalizing the National Framework.

Additional information on the national workshop, consultation process and access to reports is provided in Appendix C.

## 3. Applicability

### 3.1 Scope of Application

Petroleum refineries, for the purposes of the National Framework, are defined as facilities that process crude oil into refined petroleum products. The 20 Canadian facilities included in the scope of application of the NFPRER are listed in Table D-1 in Appendix D.[2]

The Framework does not include upgraders, which are defined as facilities that upgrade bitumen and heavy oil into synthetic crude, which is then sent to conventional petroleum refineries for further processing. While emissions and impacts from upgraders are important, there are no comparable facilities in the U.S. against which a comparison of emission performance could be made.

A definition of a refinery facility, for the purposes of emission monitoring and reporting, is provided in Appendix E.

### 3.2 Air Pollutants

The National Framework focuses on emissions of criteria air contaminants (CACs) and air toxics from the petroleum refining industry. The benchmarking analysis for the Framework currently includes the following:

- sulphur oxides (SOx);
- nitrogen oxides (NOx);
- volatile organic compounds (VOC);
- particulate matter ($PM_{10}$ and $PM_{2.5}$);
- carbon monoxide (CO); and
- benzene.

Application of the proposed health prioritization tool may lead to the identification of additional air pollutants which could be considered in the future under the proposed work to update the Framework.

---

[2] The Parkland Industries refinery in Bowden, Alberta, was closed in 2001 but has been included in case it reopens. Since the start of the NFPRER initiative, the anticipated closure of the Petro-Canada refinery in Oakville, Ontario, has been announced.

The proposed NFPRER methodology and approach for setting and prioritizing annual facility-wide emission caps is not applicable to all substances. In particular, some substances are not amenable to the emissions benchmarking approach developed for the NFPRER. For example, ammonia emissions were examined during the development of the Framework, but ammonia was not recommended for inclusion in the benchmarking analysis. There are also some substances for which local issues and considerations dominate (e.g. hydrogen sulphide), such that local environmental measures are a more appropriate course of action to protect human health and the environment.

## 4. The Elements of the National Framework for Petroleum Refinery Emission Reductions

The National Framework for Petroleum Refinery Emission Reductions consists of four main elements, which are presented in Figure 4-1.

Elements 1, 2 and 3 are outputs of the National Framework development process, and consist of:

- the **methodology** to assist jurisdictions with prioritizing and setting facility-wide refinery emission caps, including benchmarking analysis, health prioritization analysis, and an illustrative guide to assist jurisdictions with using the Framework;
- the **strategy** to **monitor and report** on refinery emissions and reductions; and
- a **ten year plan** to keep the Framework tools updated, measure performance of the Framework and report on progress.

Although the National Framework and its elements are not legally enforceable, it is the provinces, territories or delegated local governments that are currently responsible for regulating air emissions from refineries. Elements 1, 2 and 3 collectively are a set of tools, analysis and guidance for use by jurisdictions.

Element 4 of the framework is **jurisdictional management** of refineries. Jurisdictions will consider the tools and guidance from the National Framework, and can integrate these into their existing air management programs for refineries, where applicable. The NFPRER tools are intended to be complementary to any tools, strategies, regulatory instruments or other initiatives already in place or planned by the respective jurisdictions. The extent of use of the Framework will likely vary from jurisdiction to jurisdiction.

Over the next ten years, it is expected that refineries will **report** back to jurisdictions on the NFPRER. Jurisdictions would then be encouraged to share this information through CCME. The information reported by jurisdictions could include monitoring and reporting data, details on refinery emission management programs and implementation plans, and data on emission caps or emission reduction targets or other measures. CCME would be responsible for collecting the information and developing and distributing a progress report on a three year cycle, as described in Section 4.3.

Each element of the Framework is described in more detail on the next page.

**Figure 4-1 Elements of the National Framework for Petroleum Refinery Emission Reductions**


METHODOLOGY
Provision of information to facilitate setting of prioritized, facility-wide, performance-based emission caps, including:
1. Database of Canadian and U.S. refinery emissions
2. Benchmarking Analysis
3. Health Prioritization Analysis
4. Illustrative Guide
Output:
An approach developed by a multi-stakeholder group to establish priorities for emission reductions and to develop annual facility-wide emission caps.
EMISSION MONITORING AND REPORTING STRATEGY
Provision of a strategy which will achieve:
- appropriate monitoring (measurement or estimation) of emissions from petroleum refineries
- consistent and effective facility emissions reporting to local, provincial and federal authorities and to the public
Output:
A strategy developed by a multi-stakeholder group, for monitoring and reporting facility emissions including guidance and tools, to provide credible, accurate, consistent, verifiable emission reporting.
JURISDICTIONAL MANAGEMENT
Consideration of:
1. Framework deliverables (i.e. Methodology, Emission Monitoring and Reporting Strategy, and Ten Year Plan), NFPRER goals, objectives and principles
2. Jurisdictional considerations (e.g. local/regional air quality issues, current programs and requirements, refinery initiatives, stakeholder consultation)
to develop and implement:
Output:
1. Formalization of annual facility-wide emission caps or other measures through a mix of regulatory instruments and other actions.
2. Application of emission monitoring and reporting strategy and provision of information to NFPRER Reporting on Progress
TEN YEAR PLAN
Provision of an integrated ten year workplan for the NFPRER which includes
i) measurement of the performance of the NFPRER against its stated goals and objectives
- development and implementation of performance indicators
- mechanism to revisit aspects of Framework as needed
ii) updating of the Framework tools, analysis, strategies and guidance
- update benchmarking, health prioritization analysis and other tools
- identification of knowledge gaps and progress to fill those gaps
- maintenance of CCME website
iii) reporting on progress
- collection of information from jurisdictions and refineries
- periodic reporting on refinery emissions, reduction trends, caps and targets where available, linkages to other programs, updates of tools, current practices
Output:
A Ten Year Plan developed by a multi-stakeholder group to:
1. measure performance of the NFPRER
2. update the Framework tools, analysis, strategies and guidance
3. provide periodic reporting on progress towards achieving emission reductions
LEGEND
responsibilities of jurisdictions currently regulating air emissions

### 4.1 Element 1 – Methodology

The methodology provides jurisdictions with an approach for setting and prioritizing annual facility-wide emissions caps. The methodology consists of the following tools and analysis:

1. database of Canadian and U.S. refinery emissions and operating parameters;
2. benchmarking analysis of Canadian and U.S. refinery performance;
3. health prioritization analysis; and
4. an illustrative guide – a step-by-step decision process to guide jurisdictions through the considerations involved in setting annual facility-wide emissions caps and assigning priorities for emission reduction.

#### 4.1.1 Benchmarking

The Benchmarking Sub-Group gathered data on emissions from Canadian and U.S. refineries, and worked with consultants to develop methods to determine how Canadian refinery emissions performance compares with performance in the U.S. Those methods were applied, based on the most currently available data, and provide jurisdictions with information on how each Canadian refinery's performance compares with U.S. performance.

More detailed information on the benchmarking methodology and analysis is provided in Appendix D, including:

- a summary of Canadian refinery emissions data; and
- the benchmarking analysis for Canadian and U.S. refineries.

Information related to background studies in support of the benchmarking analysis is provided in Appendix C.

#### 4.1.2 Health Prioritization

Similarly, the Health Prioritization Sub-Group worked with a consultant to develop software that provides a ranking of air pollutants at a given refinery in terms of the priority for emissions reduction, from a health perspective. The software was developed first as a prototype known as HEIDI (Health Effects Indicator Decision Index), and the Health Prioritization Sub-Group continued with the development of an enhanced version of the model, known as HEIDI II.

The HEIDI II software is being provided to jurisdictions as an additional tool to assist in the development of a ranking of pollutants. Sample outputs from the application of this software, using generic modelling inputs, are also being provided to jurisdictions.

The Health Prioritization Sub-Group has made the following recommendations:

1.0 that jurisdictions agree to support the inclusion of the HEIDI II model as a tool under the health prioritization component of the Framework, and consider its output; and

2.0 as part of the Ten Year Plan, that jurisdictions be encouraged to explore the assumptions inherent in the HEIDI II model, further assess its potential, and be prepared to provide feedback on its value and suggestions for improvement.

More detailed information on the health prioritization tool is provided in Appendix D.

Information related to background studies on the health implications of petroleum refinery air emissions, and in support of the development of the health prioritization analysis, is provided in Appendix C.

### 4.1.3 Illustrative Guide

The benchmarking and health prioritization analyses give jurisdictions the information to assess the emission performance of an individual Canadian refinery against the performance of comparable U.S. refineries, and assistance in determining which pollutants should be reduced first, from a health perspective. There is a wide range of additional regional and local considerations which can further influence the setting of emission caps and assignment of priorities for reduction, including but not limited to:

- localized health issues;
- community health studies and public health risk assessments;
- regional airshed issues such as ground-level ozone, secondary particulate matter, smog, visibility;
- local air quality issues, such as odour, nuisance, zoning, siting, dispersion;
- adjacent or contributing sources of pollution;
- transport of pollutants from other areas;
- ambient air quality monitoring data;
- acid deposition;
- other emission reduction or management initiatives already in place or planned;
- economic considerations such as cost-effectiveness and competitiveness; and
- local stakeholder concerns and input.

To provide a measure of consistency in the application of the Framework tools and a systematic method of addressing the various national, regional and local considerations, the third aspect of the methodology is the provision of an illustrative guide to setting and prioritizing emission caps. This guide is intended to provide assistance to jurisdictions on the series of decision steps they should consider in setting annual facility-wide emission caps. A jurisdiction may have a range of possible performance targets to consider for a given pollutant, using information from the benchmarking and health prioritization analyses, along with local and regional considerations. The illustrative guide is intended to assist with a comparison of the range of possible performance targets against the goals and principles of the NFPRER, and the relevant local and regional considerations, as a means of deciding on the appropriate cap and prioritization.

More detailed information on the illustrative guide is provided in Appendix D.

### 4.1.4 Setting and Prioritizing Caps

The overall output of the methodology is the provision of the NFPRER toolkit for use by jurisdictions, and an approach developed by a multi-stakeholder group on how to set and prioritize annual facility-wide emission caps for Canadian refineries. The tools are intended to be

complementary to the various processes, tools, methods and other requirements already in place in different jurisdictions. It is expected that some jurisdictions may not use all of the NFPRER tools, if some alternative is already available.

The implementation of the methodology by jurisdictions is discussed further in the Jurisdictional Management element (Section 4.4) below.

### 4.1.5 Keeping the Methodology Current

The benchmarking and health prioritization tools are not static. The basis for updating the tools and analysis is documented in the Ten Year Plan (Element 3), which includes assessment of the NFPRER and its tools and analysis on a three year cycle. The benchmarking analysis will be updated every three years, on the same frequency that the U.S. EPA makes available a new national inventory of emissions. The usefulness of the health prioritization model will be evaluated at the end of the first three year assessment period. These tools will complement each other for future analysis. The initial set of emissions performance benchmarking data addresses the CACs and benzene, but successful development of the health prioritization tool may lead to consideration of other substances for future emissions benchmarking analysis.

## 4.2 Element 2 – Emission Monitoring and Reporting Strategy

The Emission Monitoring and Reporting (EM&R) Strategy is the second element in the set of NFPRER deliverables. The strategy is intended to achieve the following objectives:

- appropriate monitoring (using measurement or estimation methods) of emission sources from Canadian petroleum refineries; and
- consistent and effective emissions reporting to local, provincial and federal authorities as well as to the public.

The primary goal of the strategy is to provide guidance and tools for refineries to monitor and report emissions of air pollutants and toxics in a manner that will allow jurisdictions to determine whether annual facility-wide emission limits (caps) are being achieved. Jurisdictions may adapt the EM&R Strategy if they are implementing instruments other than caps to reduce emissions of air pollutants.

The strategy has been developed under the guidance of the NFPRER Monitoring and Reporting Team, using a consultative process involving multiple stakeholders, and guided by the five key principles of relevance, completeness, consistency, transparency and accuracy. To develop the strategy, background research was conducted on sources of pollutants at refineries, and existing methods and requirements for measuring and/or estimating emissions; quality assurance and quality control (QA/QC); record keeping; reporting; and ambient air quality monitoring.

The Emission Monitoring and Reporting Strategy includes six main elements, which are summarized below. More detailed information on the Emission Monitoring and Reporting Strategy is provided in Appendix E, and supporting background studies are listed in Appendix C.

**Facility Emission Monitoring** – Based on the review of methods, the strategy recommends methods and acceptable alternatives for facility-level emission monitoring, focusing on the need to establish compliance with annual facility-wide emissions caps. Depending on factors such as the pollutant of interest, source characteristics, precision and accuracy of methods and other considerations, the methods may involve measurement and/or estimation techniques.

**Facility Emission Reporting** – The strategy outlines requirements for reporting total annual facility-wide emissions of pollutants, methodologies used to quantify emissions (for specified sources or source categories) and supporting facility information. The vehicle for reporting is intended to provide a one-window approach, harmonized with the National Pollutant Release Inventory, other reporting programs, and regulatory compliance reporting under permits and approvals. The emissions data are intended to be broadly available to jurisdictions, the public and other interested parties.

**Record Keeping for Facility Emission Monitoring and Reporting** – The strategy calls for records to be kept that demonstrate that appropriate methods have been used to quantify emissions, including source information, documentation of methods, QA/QC procedures, operating conditions. Record retention periods are also recommended.

**Quality Assurance and Quality Control** – The strategy includes requirements for facilities, jurisdictions and others to verify methodologies and procedures and validate the data that are reported. Facilities are responsible for ensuring that measurement or estimation methods are properly applied, with appropriate documentation, and for examining and understanding trends from year to year. Jurisdictions would work together to ensure coordinated data quality validation where needed.

**Ambient Monitoring and Reporting** – An assessment of the current level and manner of ambient air quality monitoring and reporting was conducted. Because ambient monitoring is used primarily to address specific local, regional and airshed issues, it was considered to be a jurisdictional matter. However, jurisdictions, industry and other stakeholders should share information on ambient monitoring, including approaches, data quality, access to data, and the role of stakeholder groups. It is noted that, where other sources of emissions are present, ambient monitoring does not provide sufficient information to assess whether emission reductions from a refinery are being achieved, but may allow a broad analysis of trends.

**Implementation** – The strategy documents roles and responsibilities associated with each element listed above.

Like the methodology tools, the strategy is intended to be complementary to current monitoring and reporting requirements. Jurisdictions and refineries have some flexibility to use alternative methodologies or approaches, to maintain alternative records, or to accommodate for unique refinery configurations where some methods may not be practical or appropriate. Generally, the rationale for using alternatives should be documented.

### 4.3 Element 3 – Ten Year Plan

The Ten Year Plan is the third element in the set of National Framework deliverables. The plan supports the achievement of the following:

- The National Framework for Petroleum Refinery Emission Reductions would be used by jurisdictions in their regulatory and policy work.
- Regulatory and other actions would be implemented by provinces and/or municipalities to set annual facility-wide emission caps or other measures for a range of air pollutants. These caps or other measures would:
  - be implemented in a prioritized and phased manner over a ten year period; and
  - result in an improved level of health protection, as a result of improved environmental performance which is at least on par with the current and anticipated performance of comparable U.S. refineries.

The Ten Year Plan provides an integrated workplan to ensure that the NFPRER is updated and that progress towards its implementation and success is reported on a three year cycle. It consists of recommendations on the collection of information from jurisdictions and refineries, and reporting on progress in reducing refinery emissions. It includes a mechanism for reviewing the NFPRER toolkit and for assessing the performance of the Framework.

The performance measures in the Ten Year Plan will encourage phased and prioritized actions to help meet the stated NFPRER goals and objectives. Interim actions to reduce emissions from petroleum refineries are encouraged within an overall ten year horizon, to provide ongoing improvement rather than focusing on the end point. The NFPRER toolkit can help prioritize emission reductions and ensure early actions to reduce the emissions that are of the greatest concern.

As the methodology, and in particular the benchmarking analysis, is updated over the next ten years, it will provide a moving target for emission reductions. The expectation is that the moving target will reflect ongoing improvements in the emission performance of U.S. refineries. These anticipated improvements will be the result of:

- actual performance improvements as new regulations, initiatives or actions are adopted in the U.S. to reduce emissions from refineries, as refining and emission control technologies improve, and as refineries which are out of compliance with permits or regulations are brought into compliance; and
- improvements in emissions reporting practices in the U.S, and reduction in variability in emissions reported.

Canadian refinery emissions will be compared with those of the continuously improving U.S. refineries. However, while U.S. improvements will tend to be driven by prescriptive laws and regulations, it is hoped that through the NFPRER, Canadian refiners will have much more flexibility to meet emission reduction targets in a manner which best suits their own situation and economics.

### 4.3.1 Performance Measurement

Over a ten year time frame, the following indicators would be used to measure performance of the NFPRER in meeting its stated goals and objectives (Appendix A):

- achievement of convergence with U.S. performance;
- reductions in refinery emissions;
- implementation of annual refinery-wide emissions caps or other instruments;
- timely availability of validated emissions data; and
- use of the Framework tools, including the benchmarking analysis, health prioritization analysis, illustrative guide and Emission Monitoring and Reporting Strategy, by jurisdictions.

These indicators would be developed further and used for the ongoing assessment of the NFPRER (see Section 4.3.4 and the schedule in Section 4.3.6).

In terms of the NFPRER goal of convergence of the environmental performance (current and anticipated) of Canadian refineries with comparable U.S. refineries, the first indicator of performance listed above will be measured by:

- the degree to which the regression line for the performance of Canadian refineries trends towards and overlays with the regression line for U.S. refineries (updated on a three year basis), with the individual Canadian refineries distributed around the regression line and within the 75% confidence interval.
  - Specifically, the emission correlation diagrams shown in Appendix D (updated on a three year basis) would provide a statistical representation of progress towards the convergence goal for each pollutant.
  - Reductions would be sought as necessary in order to achieve the overlay of the U.S. and Canadian regression lines. It is understood that jurisdictions may consider regional and local issues such as those outlined in Section 4.1.3 to require further action. Initially, any individual refinery which is outside the 75% confidence interval would be expected to move within it.

In terms of the second indicator, reductions in refinery emissions:

- Emission reductions will be measured on an absolute basis, in tonnes per year of each pollutant.
- Emission reduction trends would be analyzed from reporting period to reporting period, and relative to a specified base year, such as 2001, the first year for which benchmarking analysis was done.
- Trends in emission intensity (emissions normalized to production and other parameters which reflect the level of activity at refineries) would also be analyzed, also from reporting period to reporting period, and relative to a specified base year.

### 4.3.2 Updating of the National Framework Tools and Analysis

The National Framework and the various tools and analysis associated with the four elements have been developed through a stakeholder process using the most current information available. Over a ten year time frame, the toolkit would be updated as follows:

#### Benchmarking

- The database of U.S. and Canadian petroleum refinery emissions and operating data, and resultant emissions benchmarking analysis, would be updated on a three year cycle. This cycle would coincide with the availability of National Emission Inventory data from the U.S. EPA.
- Some of the benchmarking correlations developed on the basis of 1999 U.S. data are not statistically robust. As U.S. refinery emission performance improves, the statistical correlations used in the benchmarking analysis are also expected to improve. For example, the degree of scatter above and below the regression lines should lessen, the $R^2$ values should improve, and the confidence intervals should narrow. In the event that the correlations do not improve, adjustments may need to be made to the benchmarking methodology.

#### Health Prioritization

- The health prioritization tool will be provided to jurisdictions as part of the NFPRER toolkit. The tool has not been peer reviewed or evaluated by jurisdictions. Over the course of an initial three year assessment period, input would be requested from jurisdictions on the usefulness of the HEIDI II model, and suggestions for improvements or modifications would be sought. A decision to update the health prioritization analysis will be contingent on the success of this tool.

#### Other Tools, Guides and Strategies

- The illustrative guide and Emission Monitoring and Reporting Strategy would be updated as needed.

Additional tasks which the NFPRER Steering Committee and Sub-Groups have considered include the following:

- the identification of knowledge gaps and progress made in addressing those gaps;
- tracking of other initiatives, developments, etc, which could impact on the Framework;
- maintenance of the CCME website and other mechanisms to distribute information about the Framework;
- building capacity, by establishing or improving links among the refinery framework stakeholders and other programs or parties. The Steering Committee identified a need to exchange findings with health departments.

### 4.3.3 Reporting on Progress

Jurisdictions and refineries would provide information to CCME on refinery emission management programs, and progress towards implementation of the National Framework. The key reporting elements include:

- monitoring and reporting data, consistent with the Emission Monitoring and Reporting Strategy, including annual refinery emissions of the criteria air contaminants and benzene (the data should be validated in accordance with the Emission Monitoring and Reporting Strategy);
- available details on any refinery emission management programs and implementation plans developed; and
- available data on emission caps or emission reduction targets for refineries (which may include the rationale for decision making).

Jurisdictions would be encouraged to report on:

- linkages to other programs such as the Canada-wide Standards for Particulate Matter and Ozone, the Canada-wide Standards for Benzene, the Canada-wide Acid Rain Strategy, the Canada-United States Air Quality Agreement, and Canada-United States Ozone Annex to the Air Quality Agreement, commitments of the Conference of New England Governors and Eastern Canadian Premiers, Climate Change Plan for Canada, Large Final Emitters (NRCan), regulations and future requirements for sulphur in fuels; and
- current practices that jurisdictions or refineries may wish to share with others, to highlight available information on emission reduction programs in specific jurisdictions, which may be useful as lessons learned, or to provide other jurisdictions with ideas for their own programs. A list of current practices that may be reported on is provided in Appendix F.

### Format of the Report

A progress report on the NFPRER will be developed by CCME, with the purpose of keeping policy makers, stakeholders and the public informed about progress in reducing refinery emissions and implementation of the National Framework. The report would combine the information gathered on refinery emissions and management programs with information related to updating and refreshing the elements of the Framework. Key features of the report could include:

- annual emissions and reductions for individual refineries, including sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter ($PM_{10}$, $PM_{2.5}$) and benzene;
- emissions and reductions for the Canadian refining sector, reflecting the collective performance of all Canadian refineries to compare against overall Framework goals and objectives. This would include the updated benchmarking analyses which will show the emission performance of Canadian refineries compared with the U.S. (using periodically updated versions of the charts shown in Appendix D as a measure of performance);

- an update on, and outputs from, the tasks in the Ten Year Plan associated with updating the NFPRER tools, analyses and strategies; work to address information gaps; and any tracking of policy and other developments which are relevant to the NFPRER initiative; and
- a highlighting of information provided by jurisdictions with respect to current practices from emission reduction programs in specific jurisdictions, which may be useful as lessons learned, or to provide other jurisdictions with ideas for their own programs.

### Timing and Distribution of the Report

The report on progress of the NFPRER would be prepared on a three year cycle.[3]

The audience for the NFPRER report includes policy makers, industrial stakeholders and the general public. Accordingly, the report would be available for broad distribution; it would be accessible via the CCME website and links to that website from other stakeholders' websites.

Other complementary report formats may be developed. For example, the CPPI has a section on the NFPRER in its annual Environmental Safety and Performance Report, and has expressed an interest in expanding that section to provide additional information on the progress and achievements of the NFPRER.

### 4.3.4 Assessment of the Framework

The collection and reporting of information from jurisdictions (in 4.3.3 above) provides information needed to assess the performance of the National Framework and make interim adjustments during the Ten Year Plan.

Feedback on the NFPRER should also be requested from stakeholders. Feedback could be sought through:

- distribution of information on the CCME website;
- a request for comments attached to the periodic NFPRER reporting on progress; and
- mechanisms in use or developed within jurisdictions and communities, such as community advisory panels.

As a result of the ongoing assessment, some possible adjustments or revisions to the Framework may be required as listed below:

- The initial set of emissions performance benchmarking data addresses the CACs and benzene, but the application of the health prioritization tool may help in the consideration of other substances for future emissions benchmarking analysis. In addition, ongoing research and development on other initiatives related to health and the environment could identify other substances to be included in the NFPRER.
- Over time, it may become apparent that the Framework methodology and the application of performance-based caps is not successful for some pollutants. Under these circumstances, jurisdictions may decide to use alternative or more conventional approaches.

[3] A three year frequency is proposed, contingent on the availability of data on U.S. refinery emissions. The U.S. National Emission Inventory is currently produced every three years.

- While the expectation is that the emissions performance of U.S. refineries will continue to improve over the next decade, if the ongoing work to update the benchmark analysis shows that the overall emissions performance trend for U.S. refineries reverses and emissions increase, the Framework and its methodology should be revisited to establish another means to ensure that the overall emissions trend of Canadian petroleum refineries does not follow the U.S direction. This would be consistent with the Framework goal of maintaining any superior performance that already exists in Canada, and the principle of consistency with jurisdictional approaches such as continuous improvement.

### 4.3.5 Roles and Responsibilities

In developing the Ten Year Plan, the question of who would be responsible for these tasks was discussed. There was a consensus to integrate the strategy and tasks wherever possible with broader, related initiatives to avoid duplication of effort and to ensure that refineries are not looked at in isolation. Several options have been discussed, including:

1. an ad hoc multi-stakeholder task group that is convened on a periodic basis (expected to be every three years);
2. an ongoing multi-stakeholder task group;
3. an ongoing intergovernmental working group;
4. a periodic intergovernmental working group;
5. an NAICC-A network;
6. resources within Environment Canada; and
7. provincial reporting similar to requirements under the Canada-wide Standards.

These options are listed in order of preference by the NFPRER Steering Committee. Option 1, a multi-stakeholder task group that is convened on a periodic basis (expected to be every three years), is recommended. After consulting the Environmental Planning and Protection Committee of CCME, the chosen option is an ad hoc multi-stakeholder task group (option 1) convened on a periodic basis by CCME.

### 4.3.6 Schedule

| Year | Task | Reference Section(s) | Recommended Responsibility |
|---|---|---|---|
| 2004 | Launch Framework | | |
| 2005 | Update tools | | |
| | • Benchmarking | 4.3.2 | Environment Canada |
| 2008 | Update tools | | |
| | • Benchmarking | 4.3.2 | Environment Canada |
| | • Review health prioritization tool | 4.1.2, 4.3.2 | feedback from jurisdictions |
| | • Other tools as needed | 4.3.2 | to be determined |
| | Three year progress report and assessment of performance | 4.3.1, 4.3.3 | CCME with a multi-stakeholder task group |

| Year | Task | Reference Section(s) | Recommended Responsibility |
|---|---|---|---|
| 2011 | Update tools | | |
| | • Benchmarking | 4.3.2 | Environment Canada |
| | • Other tools as needed | 4.3.2 | to be determined |
| | Three year progress report and assessment of performance | 4.3.1, 4.3.3 | CCME with multi-stakeholder task group |
| 2014 | Update tools | | |
| | • Benchmarking | 4.3.2 | Environment Canada |
| | • Other tools as needed | 4.3.2 | to be determined |
| | Three year progress report and assessment of performance | 4.3.1, 4.3.3 | CCME with multi-stakeholder task group |
| 2015 | Ten year progress report and assessment of performance; develop next ten year plan | 4.3.1, 4.3.3 | CCME with multi-stakeholder task group |

## 4.4 Element 4 – Jurisdictional Management

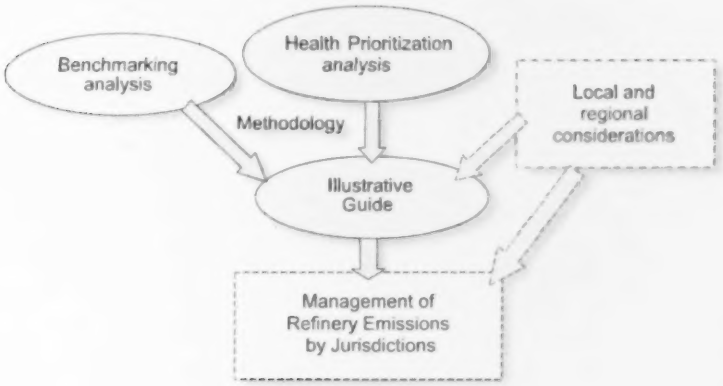
The jurisdictional management element encompasses the responsibilities of the provincial, regional and municipal regulators (for those who have the delegated authority), in cooperation with refineries, to develop, prioritize and implement annual facility-wide emission caps or other measures to manage emissions of criteria air contaminants and air toxics from each refinery in their jurisdiction.

### 4.4.1 Determining Refinery Emission Management Actions

In arriving at facility-wide caps or other management actions, the jurisdictions are provided with the methodology, Emission Monitoring and Reporting Strategy, and Ten Year Plan. These collectively form the NFPRER toolkit, or the national set of tools developed from the NFPRER initiative. All of the tools are intended to be complementary to the various processes, tools, methods and other requirements already at the disposal of jurisdictions. The NFPRER toolkit contains several tools that can be considered to assist in the jurisdictional management process. It is expected that some jurisdictions may not use each of the NFPRER tools if some alternative is already available within that jurisdiction.

The Framework tools are to be used in conjunction with a series of local considerations, including but not limited to local and regional air quality issues, health issues, zoning and siting, acid deposition, transboundary issues, odour issues and others. As shown in Figure 4-2, the illustrative guide is one tool which can be used to guide jurisdictions through the process of reviewing the benchmarking and health prioritization analysis, and then combining that information with additional considerations from the regional and local perspectives.

**Figure 4-2: Application of Methodological Tools in Jurisdictional Management**




The setting of emission targets or other policy for refineries is the responsibility of jurisdictions. The benchmarking and health prioritization analysis provide information on how the emission performance of an individual Canadian refinery compares with that of comparable U.S. refineries, and a relative ranking of priorities for emission reduction, respectively. However, while convergence with U.S. performance is one goal of the NFPRER, jurisdictions may deem it necessary to go beyond the convergence approach.

Jurisdictions are not precluded from using other approaches or instruments that are necessary to protect human health and the environment. The Framework toolkit is meant to be complementary to other mechanisms that are the responsibility of jurisdictions. These mechanisms will vary from jurisdiction to jurisdiction, but may include:

- source-specific requirements (possibly in combination with facility-wide caps);
- emission caps which are based on shorter durations, such as monthly, daily or hourly;
- point of impingement standards;
- dispersion modelling;
- ambient air quality monitoring;
- stack emission concentration limits;
- requirements for episodic releases;
- requirements to address nuisance issues; and
- requirements for spills, accidental releases and incidents.

### 4.4.2 Intensity Basis

The benchmarking analysis assesses annual facility-wide emissions based on "intensity." For example, emission limits can be expressed in terms of tonnes of emissions per unit of crude processed or per unit of aromatics extraction capacity. Jurisdictions may be faced with situations where a refinery increases production or expands capacity. Where these circumstances could

lead to increased emissions, it is expected that a jurisdiction would reassess the positioning of this refinery against the most current benchmarking analysis and review local and regional considerations as part of its decision-making process.

### 4.4.3 Timing Issues

Progress in reducing emissions at refineries may not be a gradual process – it is more likely that progress will be made as a series of step change reductions. Industry will require a certain amount of lead time to plan for the investments (replacement or upgrading of equipment, installation of new emission control technology, modifications to refining processes, etc.) that will be needed over the next ten years to reduce emissions, and to schedule them with refinery maintenance turnarounds.

Given that jurisdictions set emissions requirements with varying frequencies, some shorter and some longer (e.g. ten years), it is recommended that jurisdictions take into consideration the following when establishing caps, targets or policy:

- to adequately respond to expected future improvement in U.S. emission performance; and
- to take into consideration industry's need for longer timelines for capital planning and investments.

### 4.4.4 Instruments for Implementation

The details of implementation will be largely up to the individual jurisdiction, but could include a schedule for establishing and implementing caps, the specifics of how these will be formalized in a legally binding instrument (e.g. permits, regulations or certificates of approval) or other action, the public review process, the monitoring and reporting requirements, and other aspects.

## 5. Looking Ahead

Implementation of the Framework will be a gradual process, given the number of jurisdictions involved and their role in managing emissions from petroleum refineries in Canada. The differing phases and degrees of implementation could present a challenge for data collection and reporting on progress in the short term.

The Steering Committee that has developed the Framework acknowledges that the toolkit should be dynamic and may need revisions or improvements over time. The end-user jurisdictions are encouraged to provide feedback on their experiences with the toolkit – how it works, useful features, improvements needed and lessons learned. Feedback will also be sought from other stakeholders, including industry and the public.

The NFPRER Steering Committee recommends that an ad hoc multi-stakeholder task group be formed, and that this group be convened by CCME on a three year basis to carry out the tasks identified.

## 6. Alternative Views

During the course of the development of the National Framework, a number of dissenting or alternative viewpoints were voiced by participating stakeholders. These issues were unresolved at the time of writing of this document and are listed below (in no particular order):

- The representative from STOP, an environmental NGO, has expressed the viewpoint that a facility emission cap is not appropriate for dealing with emissions of VOC and air toxics (such as benzene). VOC are precursors to ozone formation, many species are air toxics, and they can lead to localized odour concerns. Also, significant amounts of VOC from refineries are released from ground-level fugitive emission sources and may not be dispersed to the same extent as pollutants discharged from stack releases. STOP believes that more-prescriptive command and control approaches would be more appropriate for VOC and benzene. This viewpoint has been supported by the representative from the Saint John Citizens Coalition for Clean Air.
- The representative from STOP has proposed an alternative approach to setting emission caps for NOx. The approach would use the NOx emission limits published in the CCME National Emission Guideline for Commercial/Industrial Boilers and Heaters, which sets emission limits in grams per gigajoule of energy input for new fossil fuel-fired boilers and heaters. The guideline applies to a variety of gaseous and liquid fuels, but not to solid fuels such as petroleum coke. These limits could be applied to the fuel input at refineries to set an alternative cap based only on combustion sources.
- The representative from STOP disagrees with the use of emission factors alone in the determination of compliance with legally enforceable emission caps. The representative from STOP formally disagrees with Note 1, Table E-1, Appendix E. Stack sampling should be required at least every two years, except in cases of safety limitations or inaccessibility. After careful consideration and consultation with the STOP representative, the Saint John Citizens Coalition for Clean Air representative supports this viewpoint.
- In order to properly evaluate the NFPRER as a process for emission reduction, and to modify it if necessary, the representative from the Occupational Health Clinics for Ontario Workers (OHCOW), Sarnia-Lambton, believes that measurable performance criteria must be specified and applied at the midpoint of the ten year time frame. OHCOW cannot endorse the subjective performance measures outlined in Section 4.3.1.
- The representative from the Occupational Health Clinics for Ontario Workers, Sarnia-Lambton, would like to clarify that the target of 50% emission reductions for some pollutants at some facilities and the convergence approach (noted in the Introduction and in the Terms of Reference) were non-negotiable aspects of the proposed initiative. OHCOW does not fully endorse the approach or the proposed outcome.

## 7. List of Acronyms and Abbreviations Used

| | |
|---|---|
| **CACs** | criteria air contaminants |
| **CCME** | Canadian Council of Ministers of the Environment |
| **CO** | carbon monoxide |
| **CPPI** | Canadian Petroleum Products Institute |
| **CWS** | Canada-wide standards |
| **EM&R** | emissions monitoring and reporting |
| **EPPC** | CCME Environmental Planning and Protection Committee |
| **HEIDI** | Health Effects Indicator Decision Index |
| **M&R** | monitoring and reporting |
| **NAICC-A** | National Air Issues Coordinating Committee – Other Air Issues |
| **NFPRER** | National Framework for Petroleum Refinery Emission Reductions |
| **NGO** | non-government organization |
| **NOx** | nitrogen oxides |
| **NPRI** | National Pollutant Release Inventory |
| **PM** | particulate matter |
| **$PM_{10}$** | respirable particulate matter, less than 10 microns in diameter |
| **$PM_{2.5}$** | inhalable particulate matter, less than 2.5 microns in diameter |
| **QA/QC** | quality assurance and quality control |
| **SOx** | sulphur oxides |
| **U.S. EPA** | United States Environmental Protection Agency |
| **VOC** | volatile organic compounds |

## 8. Glossary of Terms

### Air toxics

Those pollutants known to cause or suspected of causing cancer or other serious health problems. Health concerns may be associated with both short and long term exposures to these pollutants. Many are known to have respiratory, neurological, immune or reproductive effects, particularly for more susceptible sensitive populations such as children. The terms "toxic air pollutants" and "hazardous air pollutants " (HAPs) are sometimes used.

### Ammonia

Ammonia gas ($NH_3$) is a colourless, acrid-smelling gas that is volatile and highly water soluble. It originates from both man-made and natural sources. Gaseous ammonia reacts chemically with other gases and particles and can produce secondary particulate matter with diameters less than 2.5 µm (i.e. $PM_{2.5}$). These fine particles cause the greatest concern for human health. Particulate matter and ammonia are also linked to air quality issues such as reduced visibility.

### Attainment area

A term used in the U.S. to describe a geographic area that meets the national ambient air quality standards (NAAQS) for the U.S. Criteria Air Contaminants: carbon monoxide, particulate matter, ozone, nitrogen dioxide, sulphur dioxide and lead. Attainment status is determined on the basis of individual contaminants; an area can be in attainment for any given criteria air contaminant, but out of attainment for others. Attainment area status is determined by the U.S. EPA and drives State Implementation Plans and the technology that must be used to control air emissions from new sources in the area.

### Benchmarking

Generally speaking, is the process of improving performance by continuously identifying, understanding and adapting outstanding practices and processes found inside and outside the organization. As applied in this Framework, benchmarking of regulatory regimes involved a review and analysis of how petroleum refineries are regulated in the United States, the European Union, the United Kingdom, Germany and Japan, and a comparison to regulatory practices for refineries in Canada. Benchmarking of emissions performance involved a review of petroleum refinery emissions in Canada compared with comparable refineries in the U.S, and the development of techniques to equitably compare their emissions performance.

### Carbon monoxide (CO)

A colourless, odourless, tasteless, non-corrosive, highly poisonous gas of about the same density as air. When it enters the bloodstream, CO inhibits the blood's capacity to carry oxygen. CO is a product of incomplete burning of fuels.

### Clean Air Act (CAA)

A U.S. EPA environmental act originally enacted in 1970 and later amended in 1990 to protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population. It is organized into nine sections, or Titles, to address a variety of air issues and air pollution sources. Among other issues, industrial facilities are permitted under the CAA, and ambient air standards are established. The CAA is typically implemented through delegated authority to states and local air boards.

### Convergence

As applied in this Framework, generally means that the emissions performance of Canadian refineries will be at least on par with the current and future performance of comparable U.S. refineries. It is expected that the emissions performance of U.S. refineries will continue to improve over the next decade, as new regulations, initiatives or actions are adopted in the U.S. to reduce emissions from refineries, and as refining and emission control technologies improve.

A more quantitative definition of convergence, in the context of the benchmarking analysis and the Ten Year Plan, is that: "the regression line for the performance of Canadian refineries will overlay the regression line for U.S. refineries within ten years, with the individual Canadian refineries distributed around the regression line and within the 75% confidence interval."

**Criteria air contaminants (CACs)**

As defined by Environment Canada, comprise oxides of nitrogen (NOx), sulphur dioxide ($SO_2$), carbon monoxide (CO), volatile organic compounds (VOC) and particulate matter, including total particulate matter (TPM), particulate matter with a diameter less than or equal to 10 microns ($PM_{10}$) and particulate matter with a diameter less than or equal to 2.5 microns ($PM_{2.5}$).

**Disability Adjusted Life Years (DALYs)**

A measure of the burden of disease that reflects the total amount of healthy life lost including time lived with a disability and the time lost due to premature death. The DALY measure strives to tally the complete health burden associated with a particular disease. Key elements in the calculation of the DALY include (i) duration of time lost at each age due to death; (ii) disability weights or degrees of incapacity or suffering associated with different non-fatal conditions; (iii) age-weights, which indicate the relative importance of healthy life at different ages; and (iv) time preference, which is the value of health gains today compared to the value attached to health gains in the future.

**Facility-wide annual emissions caps**

As applied in this Framework, these are caps that: (a) set maximum emission levels for key air pollutants and air toxics, which apply to the facility as a whole, rather than to individual sources at the facility; and (b) are performance-based rather than prescriptive. That is, they do not dictate the technology facilities must use in order to achieve the required emission reductions.

**Jurisdiction**

The Canadian Council of Ministers of the Environment applies the term "jurisdiction" to federal, provincial and territorial governments. These are the governments with constitutional authority to regulate, or to employ other instruments, to address issues of interest to the CCME. In this Framework, the term jurisdiction also applies to other public agencies, such as local governments, who have been delegated the authority to permit or regulate air emissions. For example, in Canada some regional districts or municipalities are jurisdictions with such authority.

**National Ambient Air Quality Standards (NAAQS)**

Standards set by the U.S. EPA under the U.S. Clean Air Act pertaining to acceptable ambient levels of Criteria Air Contaminants.

**Nitrogen oxides (NOx), or oxides of nitrogen**

Include both nitric oxide (NO) and nitrogen dioxide ($NO_2$). Since NOx are a mixture, the combination of NO and $NO_2$ is normally reported on an $NO_2$-equivalent basis. NOx is produced in all combustion processes and is formed from the nitrogen in both the air and in fuel. NOx play an important role in the formation of ground-level ozone, can react with other contaminants such as ammonia to form secondary particulate matter, and contribute to the formation of acid rain.

**Non-attainment area**

A term used in the U.S. to describe a geographic area that exceeds the national ambient air quality standards (NAAQS) for the U.S. Criteria Air Contaminants. Compare to **Attainment area**.

### Ozone

A colourless gas made up of three atoms of oxygen. Ground-level ozone is a component of smog and has been linked to both human health and environmental health effects. Elevated levels of ground-level ozone develop most readily under conditions of warm ambient air and sunlight as a result of reactions between precursor contaminants such as VOC and nitrogen oxides. Ozone precursors are emitted from both natural and anthropogenic sources, including fuel combustion, paints, solvents and biogenic emissions from vegetation. (Ground-level ozone should be distinguished from stratospheric ozone, which is a protective layer of ozone high in the atmosphere, 19 to 30 kilometres above the surface of the planet. The ozone layer protects the planet surface from harmful forms of sun energy because it absorbs ultraviolet light. Stratospheric ozone depletion is linked to use of manufactured chemicals, such as chlorofluorocarbons or CFCs.)

### Particulate matter

Refers to microscopic bits of solid and liquid that remain suspended in the air for some time. Particles give smog its colour and cause the reductions in visibility. Direct particulate matter (PM) enters the outdoor air from many sources, principally from fossil fuel combustion by industrial and non-industrial sources, from the transportation sector, and from forest fires and wood-burning stoves. Indirect or secondary formation of PM results when particulates are formed by chemical and physical reactions of precursor substances (NOx, SOx, VOC and ammonia). Particles range in size, shape and chemical composition but are typically grouped into $PM_{10}$ (inhalable, less than 10 microns in diameter), $PM_{2.5}$ (respirable, less than 2.5 microns in diameter) and ultra fine particles of less than 1.0 micron. There is increasing evidence that not only the mass, but also the surface area, shape and chemical nature of these particles play a role in the health outcomes of individuals exposed to particulate matter.

### Petroleum refineries

For the purposes of the National Framework, these are defined as facilities that process crude oil into refined petroleum products. There are 20 Canadian facilities that are included in the scope of application of the NFPRER, and these are listed in Table D-1 in Appendix D.

The Framework does not include upgraders, which are defined as facilities that upgrade bitumen and heavy oil into synthetic crude, which is then sent to conventional petroleum refineries for further processing.

### Precursor substances

In terms of air quality, are those contaminants that combine in the atmosphere to form substances of concern. For example, nitrogen oxides and volatile organic compounds are precursors to ozone. Similarly, secondary particulate matter can be formed in the atmosphere from reactions involving NOx, SOx, VOC, ammonia and other precursor substances.

### Sulphur oxides (SOx)

Include $SO_2$ and $SO_3$ and sulphate ($SO_4$) forms. $SO_2$ (sulphur dioxide) is a non-flammable, non-explosive, colourless gas which is produced during the combustion of fossil fuels that contain sulphur. Like NOx, SOx are a precursor to the formation of secondary particulate matter and are an important contributor to acid rain.

**Volatile organic compounds (VOC)**

A loosely defined group of compounds containing at least one carbon atom that are volatile (evaporate readily) and organic in origin. They are substances that can photochemically react in the atmosphere. In addition, VOC are precursors to the formation of secondary particulate matter and ground-level ozone. The NPRI defines them as "volatile organic compounds that participate in atmospheric photochemical reactions," but excludes a number of individual substances or groups of substances such as methane and ethane from the definition. They are emitted through combustion processes and from the evaporation of materials with volatile organic content, such as petroleum products, paints and solvents, and from naturally occurring sources.

## Appendix A:

### Terms of Reference for Development of a Canadian Council of Ministers of the Environment (CCME) National Framework for Petroleum Refinery Emission Reductions

The National Framework for Petroleum Refinery Emission Reductions will provide a set of principles and methods to assist jurisdictions to establish facility emissions caps for criteria air pollutants and air toxics from petroleum refineries. It is expected that substantial reductions will be achieved (in the order of 50% of some parameters at some facilities). This initiative does not preclude jurisdictions from undertaking other actions that they deem necessary to protect human health and the environment. It is complementary to the Federal Agenda on Vehicles, Engines and Fuels and the Canada-wide Standards for Particulate Matter and Ozone.

The development of the National Framework for Petroleum Refinery Emission Reductions will be guided by the following goals:

- Protection of human health and the environment;
- Achievement of real, quantifiable, verifiable emission reductions that will contribute to improved air quality, both locally and regionally; and
- Convergence of the environmental performance (current and anticipated) of Canadian refineries with comparable U.S. refineries, in a manner that:
  - preserves the competitiveness of the petroleum refining sector in Canada; and
  - maintains any superior performance that already exists in Canada.

#### Objectives

- Establish the principles and methods for setting facility-level emissions caps for criteria air contaminants and air toxics;
- Establish a prioritized and phased 10-year action plan for reduction of emissions of criteria air contaminants and air toxics from the refining sector, consistent with national, provincial and local priorities;
- Establish a monitoring and reporting strategy so that progress on performance improvements could be monitored and reported by refineries and jurisdictions in an open and transparent manner; and
- Recommend a Framework that jurisdictions can adopt.

### Principles

The process to develop the National Framework for Petroleum Refinery Emission Reductions will:

- Proceed in a timely manner, to establish a framework including principles and methods to set facility caps within two years from the beginning of the process;
- Focus on flexible approaches that set limits on emission performance that lead to positive environmental and health outcomes, rather than prescribing specific technologies;
- Engage interested stakeholders in decision making in an open and transparent manner;
- Take into account wherever possible the monitoring and reporting requirements of existing and/or potential initiatives, such as emissions trading schemes, National Pollutant Release Inventory, etc.;
- Take into account the time frame established by the Kyoto Protocol, as well as clean air initiatives such as Canada-wide standards;
- Provide a consistent level of environmental performance and health protection associated with petroleum refineries across Canada;
- Be consistent with jurisdictional approaches such as continuous improvement or keeping clean areas clean;
- Be consistent with the precautionary principle, as articulated in Rio Principle 15.[4]

### Expected Outcomes

- The National Framework for Petroleum Refinery Emission Reductions would be adopted by all jurisdictions that regulate air emissions from refineries;
- Regulatory and other actions would be implemented by provinces and/or municipalities to set facility-level annual caps for emissions of a range of air pollutants from Canadian petroleum refineries, including sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter (total, $PM_{2.5}$, $PM_{10}$) and benzene:
  - in a prioritized and phased manner over a 10-year time period; and
  - resulting in an improved level of health protection, as a result of improved environmental performance, at least on par with current or anticipated performance of comparable U.S. refineries.

[4] Rio Principle 15: Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

## Appendix B:

## Membership in the NFPRER Steering Committee and Sub-Groups

| Name | Affiliation | Steering Committee | Benchmarking Sub-Group | Health Prioritization Sub-Group | Framework Development Sub-Group | Monitoring and Reporting Team | Communications and Consultations Sub-Group |
|---|---|---|---|---|---|---|---|
| Angle, Randy | Alberta Environment | Co-chair | | Member | Co-chair | | |
| Archambault, Raynald | *Ministère des Ressources naturelles, de la Faune et des Parcs du Québec* | Member | Member | | Member | | |
| Ayres, John | Environment Canada | | | | | Corresponding Member | |
| Baltais, Peter | Imperial Oil | | | | | Member | |
| Beaudet, France | Environment Canada | Observer | Member | Member | Member | Member | Member |
| Begoray, Larry | Alberta Environment | | Member | | | Member | |
| Bourassa, Yves | Ville de Montreal | Alternate | | | Member | Leader | |
| Bower, Barry | Ontario Energy | Member | Co-chair | | | | |
| Bryden, Barbara | Nova Scotia Environment | Corresponding Member | | | Corresponding Member | | |
| Brulotte, Raynald | *Environnement Québec* | Observer | | | | | |
| Carignan, Gene | Petro-Canada | | | | Member | | |
| Carter, Howard | Imperial Oil | | | Member | | | |
| Chamberland, Claude | Shell Canada | | | | | Member | |
| Chenier, Carl | Environment Canada | Member | Observer | Co-chair | Member | Observer | Member |
| Christopher, Cindy | CPPI–Imperial Oil | Member | | | | | |
| Constantineau, Muriel | Environment Canada NAICC–A Secretariat | Secretariat | | | | | |
| Dalzell, Gordon | Saint John Citizens Coalition for Clean Air | Member | Member | Member | Member | Member | Member |
| DeBellefeuille, Gilles | Ultramar | | | | Alternate | | |
| Drouin, Dr. Louis | *Direction de la sante publique de Montréal Centre* | Member | | | | | |
| Ertel, Gerry | Shell Canada | | | | Alternate | | |
| Ferguson, Duncan | B.C. Ministry of Water, Land and Air Protection | Corresponding Member | | | | | |
| Forristal, Peter | Industry Canada | Observer | | | Member | | |
| Granville, Geoff | Shell Canada | | | Alternate | | | |
| Grass, Don | New Brunswick Dept. of Environment and Local Government | Member | Member | Observer | Member | Member | Observer |

| Name | Affiliation | Steering Committee | Benchmarking Sub-Group | Health Prioritization Sub-Group | Framework Development Sub-Group | Monitoring and Reporting Team | Communications and Consultations Sub-Group |
|---|---|---|---|---|---|---|---|
| Hewitt, Tom | Imperial Oil | | Member | | Member | | |
| Hunter, Bill | Petro-Canada | | Member | | | Member | |
| Hutchinson, Therese | Occupational Health Clinics for Ontario Workers, Sarnia-Lambton | Member | | Member | Member | Member | |
| Johnson, Darryl | Newfoundland Dept. of Health and Community Services | Observer | | | | | |
| Keefe, Roger | Imperial Oil | | | Alternate | | | |
| Kilpatrick, Donna Jean | Environment Canada | | Observer | | Observer | | |
| Loi, Eric | Ministry of the Environment Ontario | | | | Alternate | | |
| MacDonald, Stephen | Health Canada | Member | | | Member | | |
| MacKinnon, Barbara | Canadian Lung Association | Alternate | | Member | | | |
| Marler, Simone | Shell Canada | | | | | | Member |
| Mattila, Kerry | Canadian Petroleum Products Institute (CPPI) | Member | | | | | Member |
| Maybee, Kenneth | Canadian Lung Association | Member | | Co-chair | | | |
| McKellar, Ken | Sunoco | | | | Member | | |
| Monaghan, Maureen | Natural Resources Canada | Observer | Member | | | Member | |
| Moser, Adam | Industry Canada | Alternate | Member | | Alternate | | |
| Nakahara, Ken | Ministry of the Environment Ontario | | | | Member | | |
| Newhook, Ron | Health Canada | | | Member | | | |
| O'Dea, Frank | Newfoundland & Labrador Department of Environment | Member | Member | | Member | Member | |
| Patenaude, Lynne | Environment Canada | Observer | Co-chair | Member | Member | Member | Observer |
| Patterson, Dave | Shell Canada | | Member | | | | |
| Robinson, Scott | Environmental Protection Branch Saskatchewan Environment | Corresponding Member | Corresponding Member | | | | |
| Rother, Patrice | Greater Vancouver Regional District | Corresponding Member | | | | | |
| Schingh, Marie | Environment Canada | Co-chair | | | | | |

| Name | Affiliation | Steering Committee | Benchmarking Sub-Group | Health Prioritization Sub-Group | Framework Development Sub-Group | Monitoring and Reporting Team | Communications and Consultations Sub-Group |
|---|---|---|---|---|---|---|---|
| Smargiassi, Audrey | *Direction de la santé publique de Montréal Centre* | Alternate | | Member | | | |
| Snider, Andrew | Environment Canada | Member | Member | Co-chair | Co-chair | Observer | Co-chair |
| Walker, Bruce | STOP | Member | Member | Observer | Member | Member | Member |
| Waddell, Brian | Alberta Environment/ Energy | | | | | | Corresponding Member |
| Wong, Peter | Ministry of the Environment Ontario | | | | | Member | |
| Young, Paul | Petro-Canada | | | Member | | | |

The following table consists of individuals who have participated in the process at some point of development.

| Name | Affiliation | Steering Committee | Benchmarking Sub-Group | Health Prioritization Sub-Group | Framework Development Sub-Group | Monitoring and Reporting Team | Communications and Consultations Sub-Group |
|---|---|---|---|---|---|---|---|
| Chernetski, Kelly | Ministry of the Environment Ontario | | | | Member | | |
| Gomes, Pascoal | Canadian Environmental Network | Observer | | | | | |
| Kurtes, Robyn | Ministry of the Environment Ontario | | | | Member | | |
| Mortazavi, Saviz | Environment Canada | Member | Member | Member | | | Member |
| Olivastri, Beatrice | Friends of the Earth | Member | Member | | | | |
| Puppa, Dora | Environment Canada | Secretariat | | | | | |
| Ryan, Helen | Environment Canada | Co-chair | | | | | |

## Appendix C:

### Additional Sources of Information

### Benchmarking Studies and Reports

***Benchmarking of Refinery Emissions Performance***, prepared for Canadian Council of Ministers of the Environment and NFPRER Benchmarking Sub-Group, by Levelton Engineering Ltd. and Purvin & Gertz Inc. in association with $(S\&T)^2$ Inc, July 2003

***Benchmarking Regulatory Regimes of Petroleum Refineries***, prepared for Canadian Council of Ministers of the Environment, by Marbek Resource Consultants in association with AMEC E&C Services Ltd, May 2003

***Report from the Benchmarking Sub-group to the Framework Development Sub-group and the Steering Committee – CCME National Framework for Petroleum Refinery Emission Reductions***, July 2003

### Health Studies and Reports

***Health Implications of Petroleum Refinery Air Emissions – Part I Main Report***, prepared for Canadian Council of Ministers of the Environment, by WBK & Associates Inc, May 2003

***Assessment of Comparative Human Health Risk-based Prioritization Schemes for Petroleum Refinery Emission Reductions***, prepared for Canadian Council of Ministers of the Environment NFPRER Health Prioritization Sub-Group, by NERAM (Network for Environmental Risk Assessment and Management), May 2003

***Development of a Health Effects-Based Priority Ranking Scheme for Air Emissions Reductions from Oil Refineries in Canada***, prepared for Canadian Council of Ministers of the Environment NFPRER Health Prioritization Sub-Group, by NERAM, May 2004

### Monitoring and Reporting Studies and Reports

***Emission Monitoring and Reporting Strategy – Summary and Background***, prepared for Canadian Council of Ministers of the Environment and NFPRER Monitoring and Reporting Team, by Levelton Consultants Ltd, April 2004

### Communications and Consultation Reports

***National Framework for Petroleum Refinery Emission Reductions – Stakeholder Input on: National Workshop for the NFPRER February 25–26, 2004, Ottawa, Ontario and NFPRER Discussion Document, February 3, 2004***, by Levelton Consultants Ltd. and Stratos Inc, March 2004

Copies of the Executive Summaries of these reports can be obtained from the CCME website at

www.ccme.ca

Hardcopies of the reports can be requested by contacting:

Oil, Gas and Energy Branch
Air Pollution Prevention Directorate
351 St. Joseph Blvd
Gatineau, QC
K1A 0H3
Fax: 819-953-8903
E-mail: ogeb@ec.gc.ca

## Appendix D:

## Methodology

### Benchmarking Analysis

The Benchmarking Sub-Group of the NFPRER Steering Committee oversaw a study on **Benchmarking of Refinery Emissions Performance**. The objectives of this study were to:

- collect the most current information on emissions from petroleum refineries in Canada and the U.S.;
- examine factors which affect refinery air emissions, and develop methods to compare the emission performance for refineries of various sizes and complexities; and
- apply the methods developed to compare the reported emissions performance of Canadian refineries with comparable refineries in the U.S.

Air emissions data on criteria air contaminants and air toxics were gathered for 138 U.S. refineries from the U.S. Environmental Protection Agency. This database, known as the National Emission Inventory (NEI), is prepared every three years, with 1999 being the most current set of data. For the 20 Canadian refineries, the most current emissions data, for the year 2001, were obtained from a variety of sources including the CPPI, provincial government inventories and the National Pollutant Release Inventory.[5] A detailed listing of the Canadian refinery emissions data is provided in Table D-1. While these are the best data available for both Canadian and U.S. refineries, they nevertheless come from a variety of sources, using a variety of methods to quantify emissions, and therefore have some uncertainty associated with them. Emissions data quality will be a key issue for accurate and credible reporting and for ongoing comparisons between Canadian and U.S. refinery emissions performance.

There are a variety of factors which can influence emissions and affect comparisons between facilities. These factors include the size and scale of the refinery, the types of crude processed, the slate of products made, the refinery operating mode, the presence or absence of specific types of refining units, fuels used, differences in the degree of emission control (sometimes due to state or local regulatory requirements) and many others. With this in mind, the objective of the emissions benchmarking analysis was to develop mathematical correlations which could be used to "normalize" or relate emissions to some key refinery operating parameter. Key operating statistics were compiled for Canadian and U.S. refineries, including the production capacity of specific refining units, actual amounts of crude processed, crude sulphur content, operating modes and other data. For the eight air pollutants examined (SOx, NOx, CO, VOC, $PM_{10}$, $PM_{2.5}$, benzene and ammonia), many different correlations were tested in an attempt to develop adequate emission correlations. Many of the correlations use the amount of crude processed as the parameter to compare emissions. Other parameters used include the capacity of certain refining units, such as fluid catalytic cracking, fluid coking, reformer or aromatics extraction units. In some cases, an additional distinction is made based on the refinery operating mode

[5] For the emissions benchmarking study, the most currently available NPRI data were for the year 2001. For that year, NPRI data were obtained for benzene and ammonia, but not for the criteria air contaminants. Beginning in 2002, the NPRI was expanded in scope to include the criteria air contaminants, which should be of benefit to future emission analyses.

(e.g. cracking vs. coking) or the absence or presence of certain processes (with or without CO boilers, with or without lube plants, with or without aromatics extraction). More information is available in the consultant's report, as listed in Appendix C.

Figures D-1 to D-11 show the emission correlations developed for U.S. refineries for CACs and benzene, and their application to Canadian refineries. In these figures, the black squares portray the CAC and benzene emissions (in tonnes or kilograms per day) for U.S. refineries, plotted against the normalizing parameter. Using Figure D-1 as an example, the normalizing parameter is the amount of crude processed (in thousands of cubic metres per day), and the heavy black line in the centre is the mathematical correlation between SOx emissions and crude processed – it indicates that SOx emissions, in tonnes per day, would be 0.54 times the amount of crude processed plus 0.08. As can be seen in the graph, the correlation line is not a perfect fit. There are a number of emission points above and below the line which do not match well with the correlation line. In statistical terms, the "goodness of fit" of the line to the data is measured by an R-squared ($R^2$) value. An $R^2$ value of 1.0 indicates a perfect fit. For this SOx correlation, the $R^2$ value is 0.22.

The correlations developed for the various pollutants do not fit the data perfectly. This reflects in large part the challenge of using a simple linear correlation based on a few parameters to estimate emissions from complex facilities with a wide range of refinery processing and emission reduction techniques. The variability is believed to be due to both real differences in U.S. refinery emission performance and also to inconsistencies in methods used to estimate emissions. The Benchmarking Sub-Group developed a method to provide a range which would capture the uncertainty in the mathematical correlations. These ranges were based on a "75% confidence interval," shown in the sample chart as the upper and lower blue lines. These lines basically mean that one can be 75% confident that the actual emission value falls within the upper and lower confidence boundaries.

Figure D-2 shows an additional SOx correlation, for coking refineries in the U.S. All Canadian refineries can be compared with one of these two SOx correlations. Figures D-3 through D-11 show additional emission correlations for the remaining air pollutants. For Figures D-1 through D-11, emissions performance for Canadian refineries has been overlain on the U.S. correlation data. The red triangles show Canadian refinery pollutant emissions, also plotted as a function of the appropriate normalizing parameter. Looking at Figure D-1, it can be seen that Canadian SOx emissions performance is distributed above and below the correlation line, and that two refineries are above and one falls directly on the upper 75% confidence interval. In terms of the definition of "convergence" developed for the Framework, the performance of Canadian refineries would be considered to be not convergent with the U.S, since not all Canadian refinery emissions performance falls within the specified confidence interval.

Figures D-12 through D-18 show the comparison of the U.S. benchmarking correlations to the twenty Canadian refineries for each of the CACs and benzene. For each Canadian refinery, the pollutant benchmark is shown by a grey bar; the midpoint of the bar (as indicated by the black triangle) is the emission level which would be predicted by the correlation equation, and the upper and lower limits of the grey bar are the upper and lower 75% confidence interval. The

actual emission in 2001 is shown as a black square. From this, it can be seen which Canadian refineries are performing better, worse or on par with U.S. refineries with respect to emissions of SOx, NOx, CO, $PM_{10}$, $PM_{2.5}$, VOC and benzene. Although benchmarking analysis was attempted for ammonia emissions, a recommended correlation was not put forth due to significant differences between Canadian and U.S. refinery emissions of ammonia.

The benchmarking analysis is expected to be an ongoing process, with U.S. emissions performance analyzed every three years coincident with the availability of the National Emission Inventory in the U.S.

## Table D-1: Canadian Refinery Emissions Data for 2001

| Facility | Location | Province | Source | 2001* emissions (tonnes per year) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | SOx | NOx | CO | PM | $PM_{10}$ | $PM_{2.5}$ | VOC | Benzene | Ammonia |
| Chevron | Burnaby | BC | 1 | 1,170 | 352 | 165 | 163 | 114 | 65 | 240 | 1.3 | 0.0 |
| Consumer's Co-op | Regina | Sask | 2 | 2,994 | 1,330 | 1,000 | 150 | 119 | 68 | 1,000 | 14.9 | 8.8 |
| Husky | Prince George | BC | 3 | 2,457 | 72 | 1,226 | 46 | 33 | 20 | 118 | 0.0 | 0.0 |
| Imperial Oil | Strathcona | AB | 1 | 4,801 | 1,561 | 416 | 617 | 446 | 272 | 963 | 3.7 | 0.0 |
| Imperial Oil | Dartmouth | NS | 1 | 5,593 | 3,315 | 314 | 412 | 318 | 201 | 1,079 | 5.6 | 9.9 |
| Imperial Oil | Nanticoke | Ont | 1 | 6,998 | 2,069 | 1,485 | 263 | 203 | 133 | 814 | 3.8 | 3.8 |
| Imperial Oil | Sarnia | Ont | 1 | 23,938 | 2,718 | 770 | 813 | 701 | 427 | 2,222 | 10.8 | 0.4 |
| Irving Oil | Saint John | NB | 4 | 5,476 | 4,456 | 1,711 | 443 | 338 | 206 | 501 | 1.3 | 0.0 |
| North Atlantic Refining | Come By Chance | NF | 5 | 17,371 | 1,622 | 147 | 831 | 516 | 191 | 6,049 | 16.4 | 0.0 |
| Nova Chemicals Canada | Corunna | Ont | 1 | 6,022 | 2,177 | 967 | 338 | 242 | 215 | 709 | 46.8 | 0.0 |
| Parkland Industries | Bowden | AB | 1 | 562 | 59 | n.a. | n.a. | n.a. | n.a. | 635 | 5.5 | 0.0 |
| Petro-Canada | Edmonton | AB | 1 | 3,063 | 1,322 | 234 | 203 | 153 | 172 | 603 | 2.5 | 0.0 |
| Petro-Canada | Mississauga | Ont | 1 | 1,633 | 679 | 170 | 119 | 99 | 69 | 186 | 3.4 | 0.0 |
| Petro-Canada | Oakville | Ont | 1 | 5,847 | 679 | 248 | 467 | 326 | 195 | 477 | 0.8 | 0.1 |
| Petro-Canada | Montréal | Que | 1,6 | 4,172 | 1,461 | 151 | 243 | 170 | 97 | 1,027 | 17.8 | 0.0 |
| Shell Canada | Montréal | Que | 1,6 | 6,523 | 1,968 | 981 | 426 | 352 | 239 | 1,527 | 7.9 | 1.6 |
| Shell Canada, Sarnia | Corunna | Ont | 1,6 | 9,337 | 1,228 | 372 | 850 | 702 | 462 | 1,637 | 32.7 | 0.0 |
| Shell Canada, Scotford | Fort Saskatchewan | AB | 1 | 228 | 724 | 565 | 52 | 52 | 52 | 439 | 11.2 | 0.0 |
| Sunoco | Sarnia | Ont | 1 | 2,136 | 905 | 2,283 | 278 | 221 | 149 | 737 | 22.3 | 0.0 |
| Ultramar | Lévis | Que | 1 | 3,859 | 1,169 | 324 | 136 | 111 | 88 | 771 | 4.2 | 1.2 |
| | | | | 114,180 | 29,865 | 13,529 | 6,849 | 5,215 | 3,331 | 21,736 | 212.8 | 25.7 |

* Data are for 2001, unless otherwise indicated.

Source: 1 CAC data provided by refinery; benzene and ammonia data from NPRI.
Some differences have been observed between the data shown here and data compiled by provincial governments, due to exclusion of marketing terminal emissions and revisions subsequent to provincial reporting.

2 NOx and SOx data from Saskatchewan Environment, other CAC data from Environment Canada 1995 Emission Inventory; benzene and ammonia data from NPRI.

3 CAC data from B.C. Ministry of Water, Land and Air Protection 2000 Emission Inventory; benzene and ammonia data from NPRI.

4 CAC data from New Brunswick Department of Environment, 2001; benzene and ammonia data from NPRI.

5 SOx data from Newfoundland Department of Environment, 2001; NOx, CO, PM and VOC data from Environment Canada 1995 Emission Inventory; benzene and ammonia data from NPRI. Subsequent to the completion of the benchmarking study, North Atlantic Refining (NAR) provided additional data for 2002 and indicated that some of the emissions listed above for NAR for 2001 were overestimated.

6 SOx data provided include the releases from the Sulconam Inc. third-party sulphur recovery unit for the Montréal refineries and exclude SOx emissions associated with steam sales to other facilities from the Shell Sarnia refinery.

**Figure D-1: U.S. Cracking Refineries – SOx Emissions**

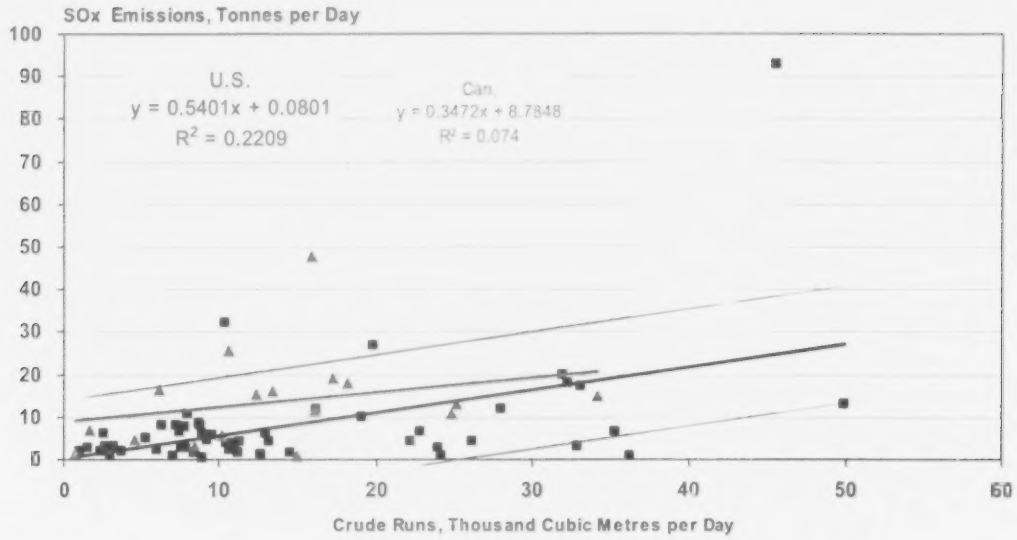



**Figure D-2: U.S. Coking Refineries – SOx Emissions**

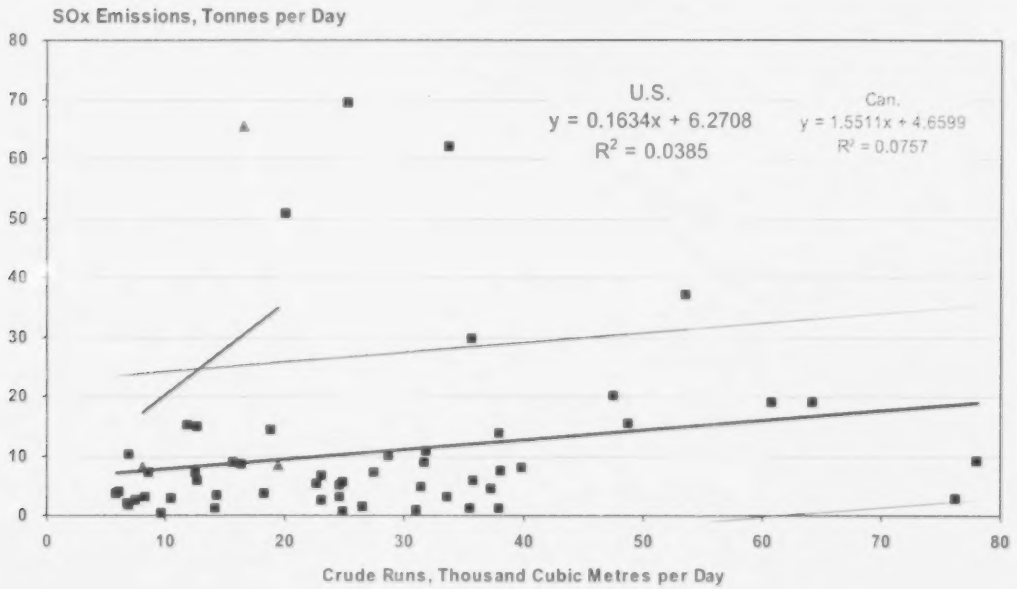


**Figure D-3: U.S. Cracking and Coking Refineries – NOx Emissions**

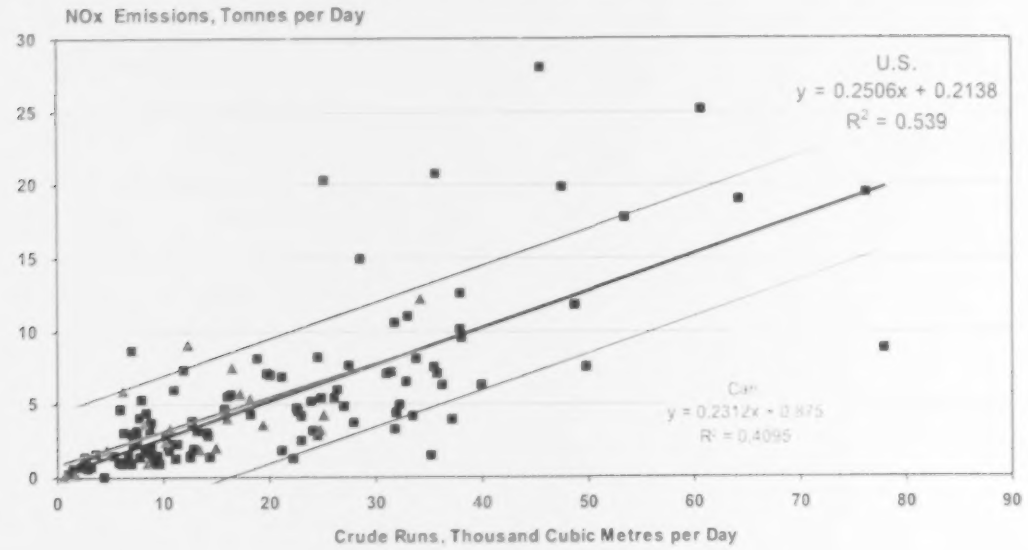



**Figure D-4: U.S. Refineries with CO Boilers – CO Emissions as a Function of FCC + Fluid Coker Capacity**

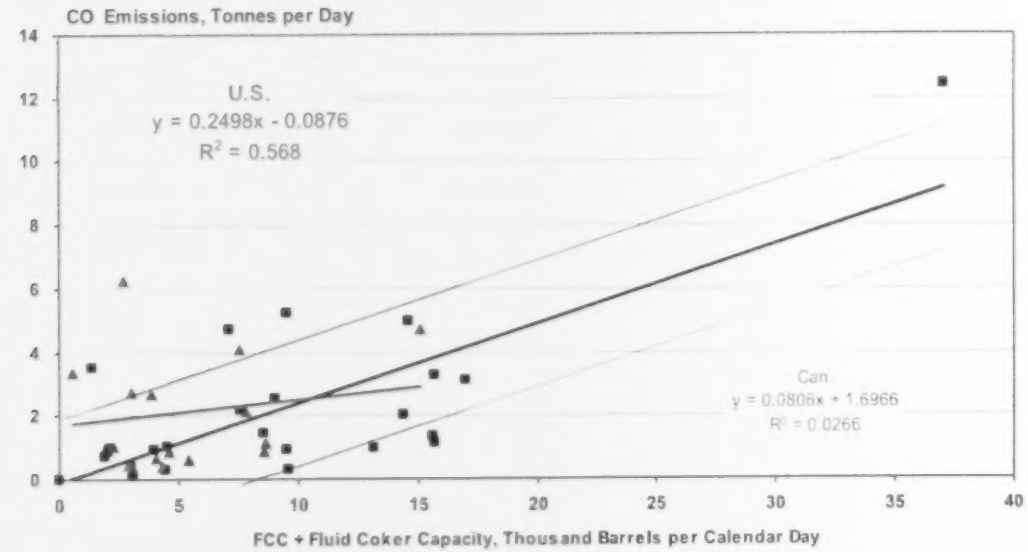

CO Emissions, Tonnes per Day
U.S.
y = 0.2498x - 0.0876
R² = 0.568
Can
y = 0.0806x + 1.6966
R² = 0.0266
FCC + Fluid Coker Capacity, Thousand Barrels per Calendar Day

**Figure D-5: U.S. Refineries with CO Boilers – CO Emissions as a Function of Crude Throughput**

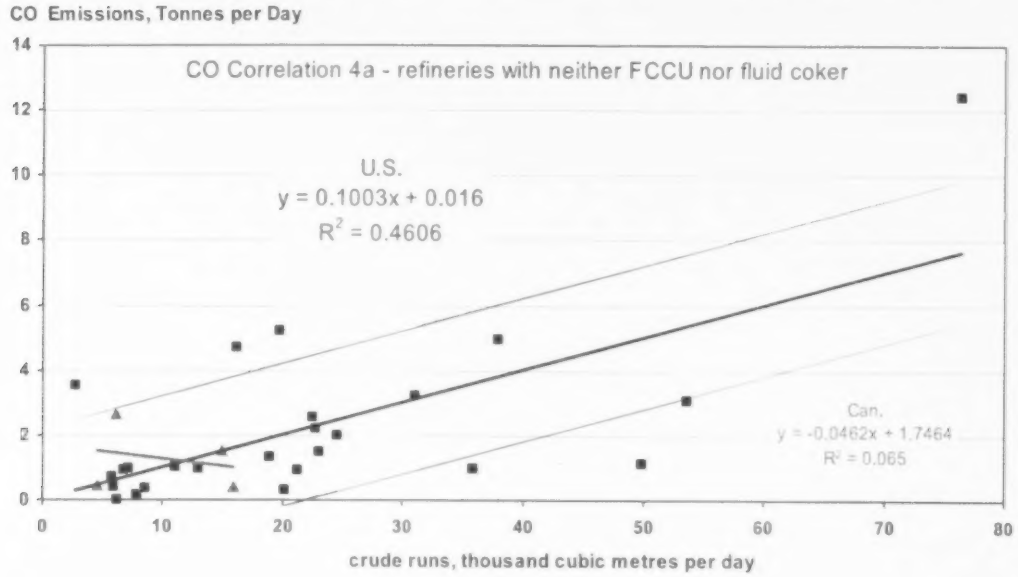

CO Emissions, Tonnes per Day
CO Correlation 4a - refineries with neither FCCU nor fluid coker
U.S.
y = 0.1003x + 0.016
R2 = 0.4606
Can.
y = -0.0462x + 1.7464
R2 = 0.065
crude runs, thousand cubic metres per day

**Figure D-6: U.S. Refineries without Lubes Manufacturing Facilities – VOC Emissions**

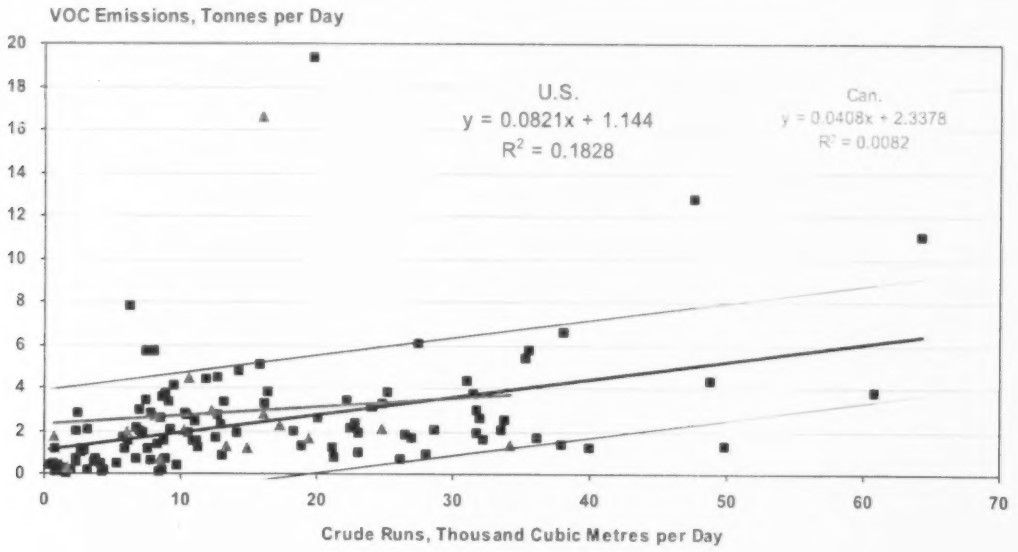


**Figure D-7: U.S. Refineries with Lubes Manufacturing Facilities – VOC Emissions**

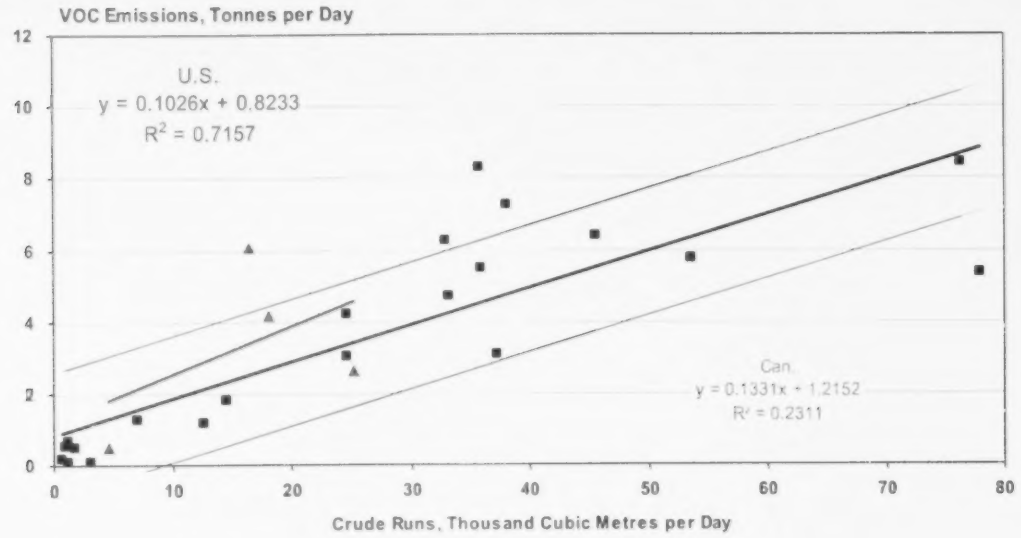



**Figure D-8: U.S. Refineries – $PM_{10}$ Emissions**

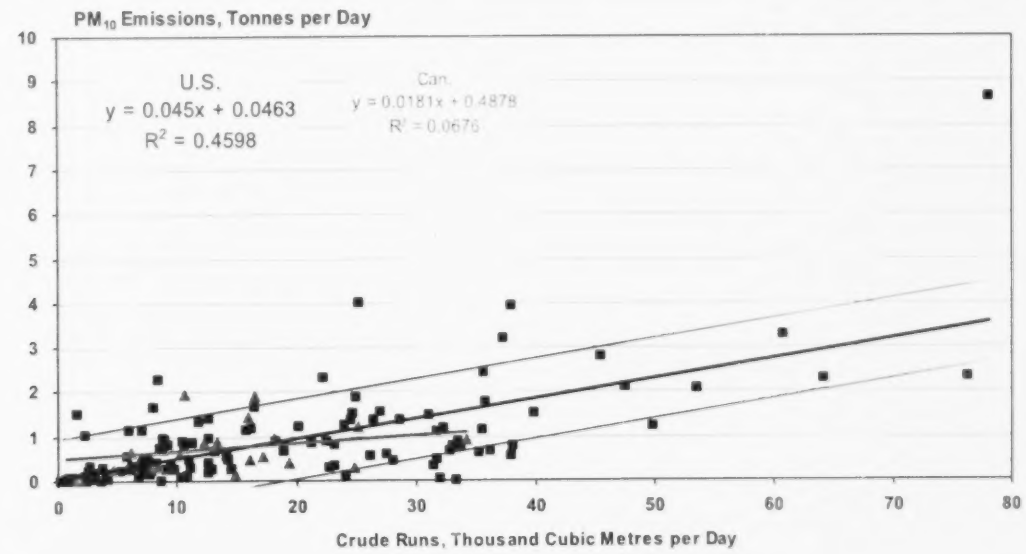


**Figure D-9: U.S. Refineries – $PM_{2.5}$ Emissions**

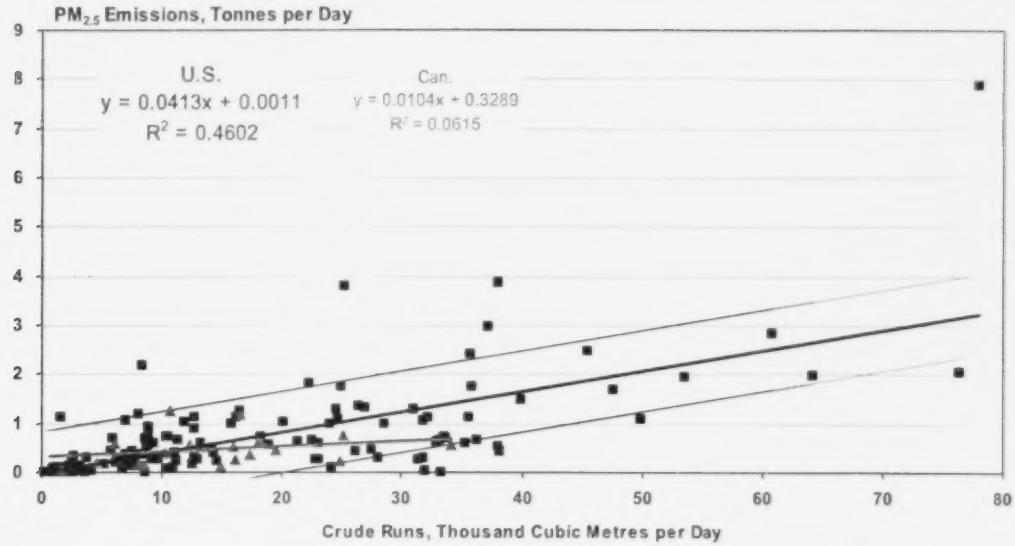



**Figure D-10: U.S. Refineries with No Aromatic Capacity – Benzene Emissions**

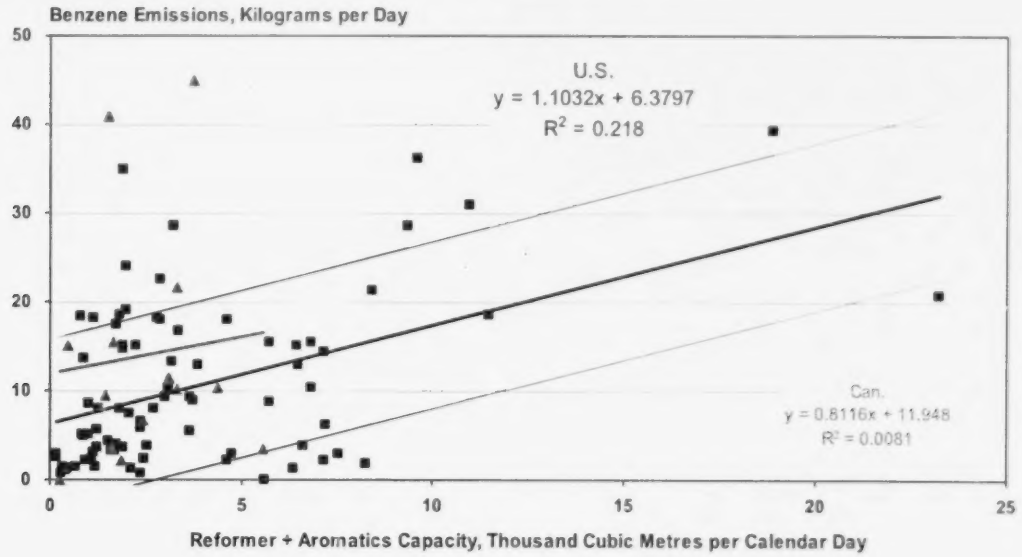


**Figure D-11: U.S. Refineries with Aromatics Extraction – Benzene Emissions**

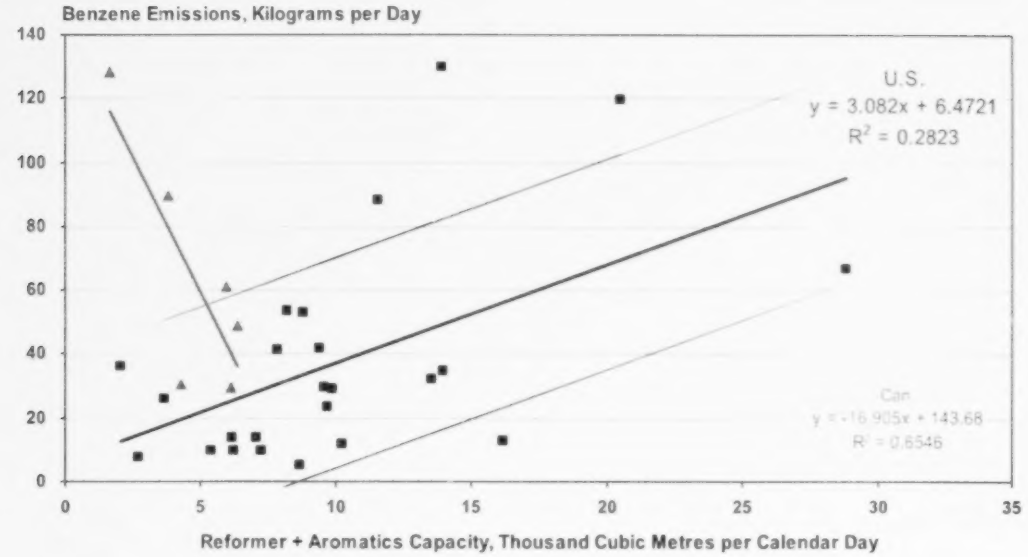
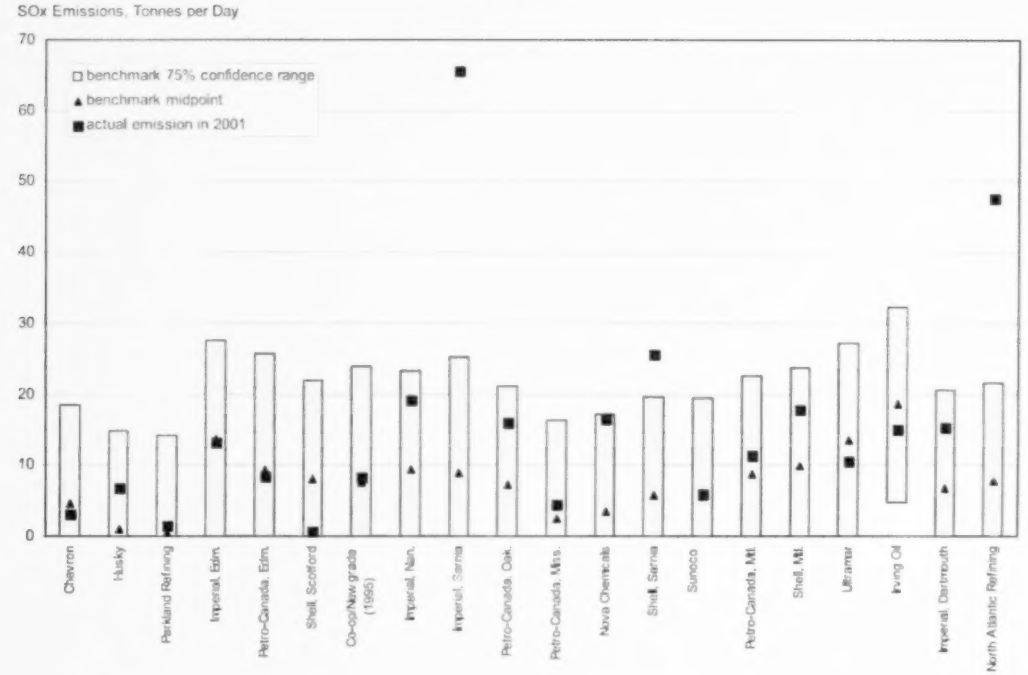
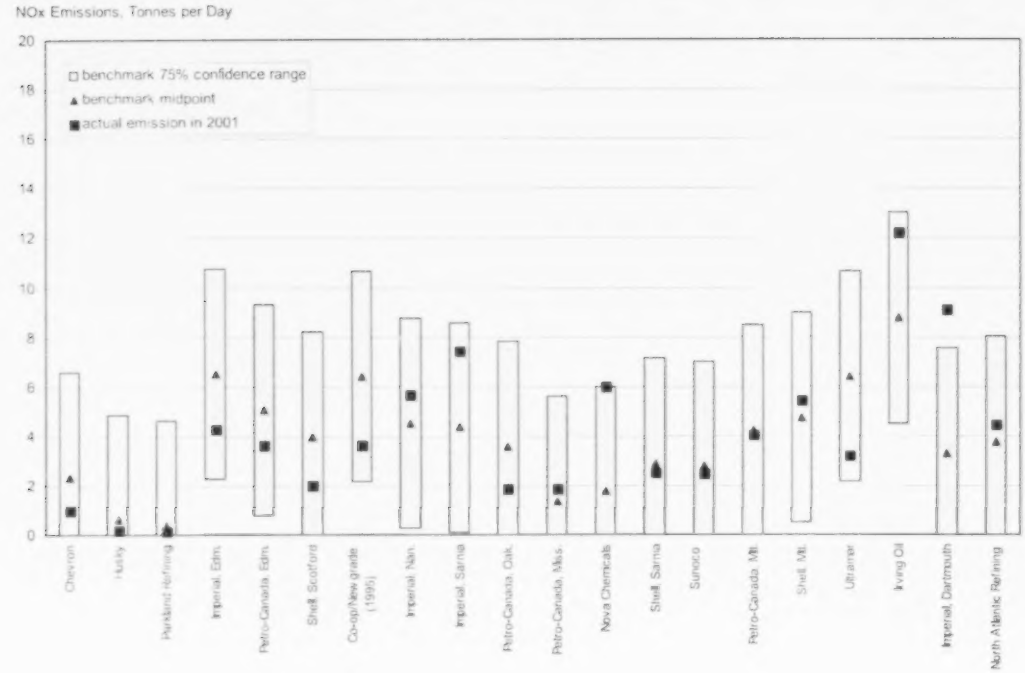


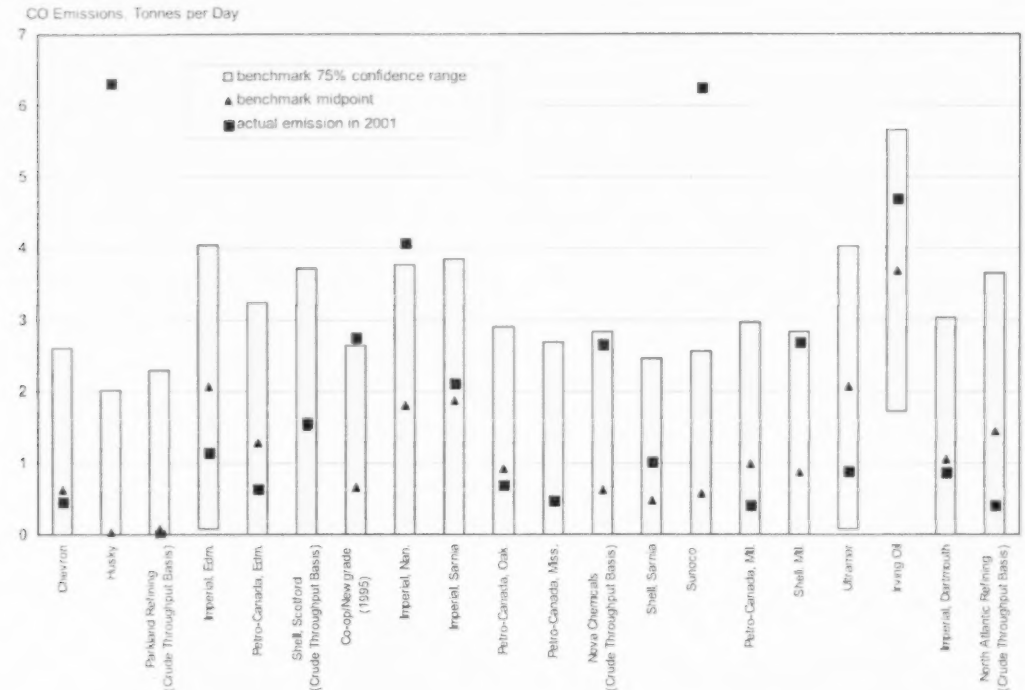

**Figure D-12: SOx Emissions Benchmarking for Canadian Refineries**



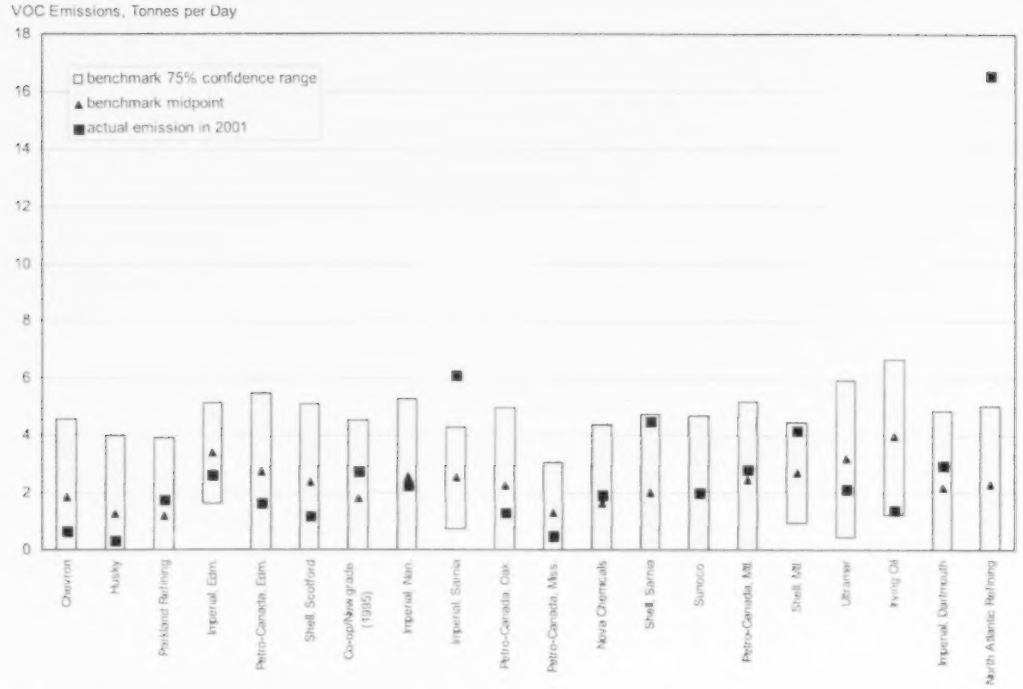
## Figure D-13: NOx Emissions Benchmarking for Canadian Refineries



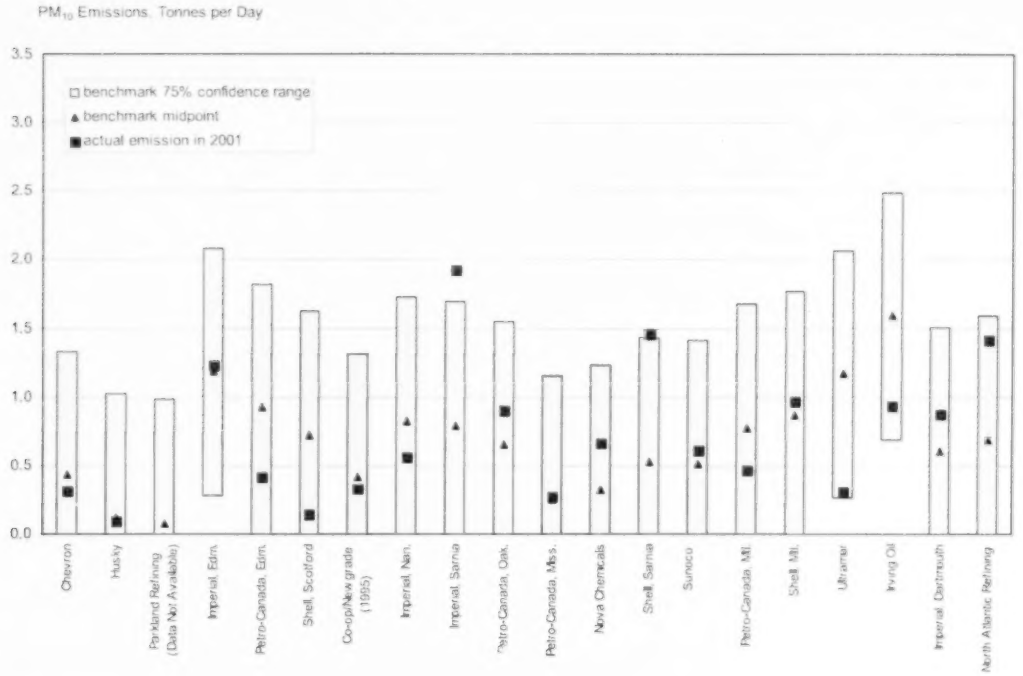

## Figure D-14: CO Emissions Benchmarking for Canadian Refineries



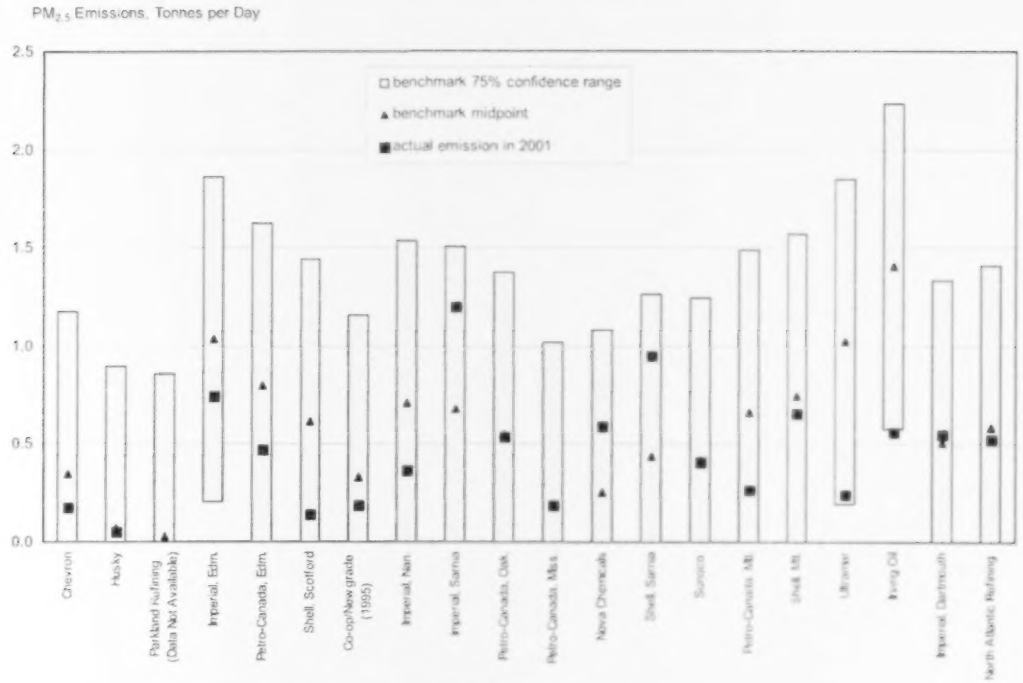
## Figure D-15: VOC Emissions Benchmarking for Canadian Refineries



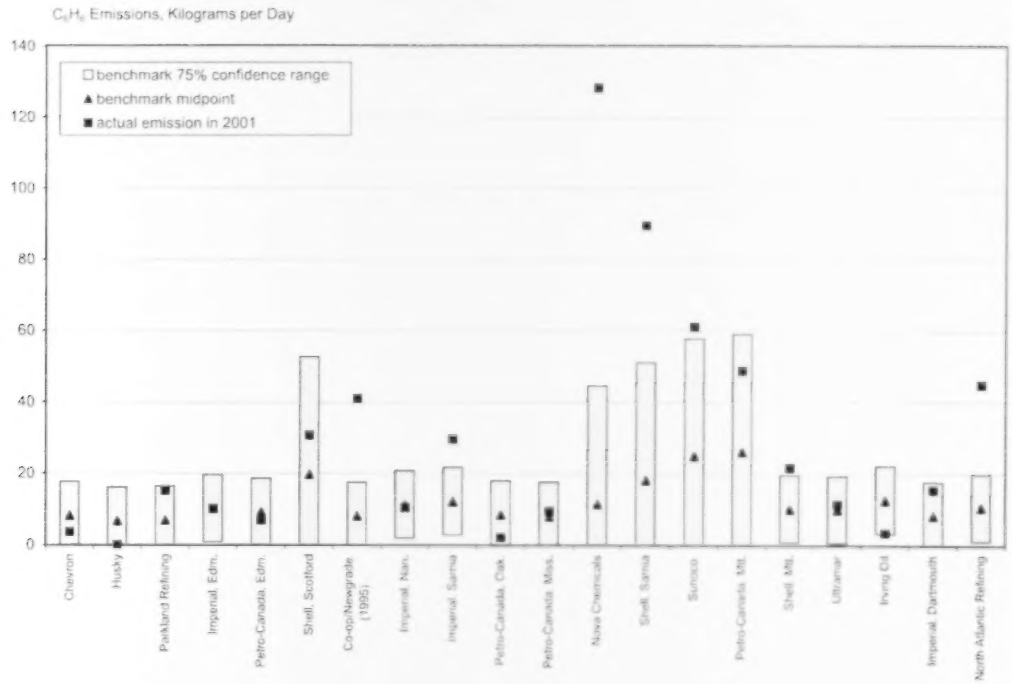

## Figure D-16: $PM_{10}$ Emissions Benchmarking for Canadian Refineries



## Figure D-17: $PM_{2.5}$ Emissions Benchmarking for Canadian Refineries




## Figure D-18: Benzene Emissions Benchmarking for Canadian Refineries



## Health Prioritization Analysis

### Background

The Health Effects Indicator Decision Index (HEIDI) Version II is a spreadsheet-based generic emission model screening-level tool that has been developed[a] to assist jurisdictions in prioritizing reductions of air emissions from Canadian petroleum refineries on the basis of relative generic ranking of risk to human health. The tool's output is a ranking of the potential health impacts associated with three classes of air emissions: (1) carcinogenic air toxics; (2) non-carcinogenic air toxics; and (3) criteria air contaminants (CACs).

### Substances Considered

HEIDI II considers 29 air toxics including all polyaromatic hydrocarbons (PAHs) as a single class and benzene, toluene, ethyl benzene, and xylene (BTEX) substances as a single class. The air toxics were selected on the following criteria: quantity of emissions reported in National Pollutant Release Inventory (NPRI) 2001, CEPA-toxic substances, substances included on Health Canada Priority Substance List (PSL) 2, and PSL scores for toxicity, persistence and bioaccumulation. It also predicts the ambient concentrations and health impacts from particulate matter (both measured primary and estimated secondary).

### HEIDI Outputs

The HEIDI II model provides an opportunity to produce a screening-level risk-based ranking of refinery NPRI emissions, to help inform users in prioritizing reductions of petroleum refinery emissions. It makes some generic assumptions in estimating the environmental fate, levels and health impacts of the various substances (e.g. stack height, meteorology), but also uses some information that is specific to each individual refinery (e.g. profile of substances emitted, background concentrations, size and distribution of local populations). Hence it is designed to generate a screening level risk-based ranking that is unique to each refinery. HEIDI II has been designed as a generic model for priority risk ranking that may be adaptable to other stationary sources of air emissions outside of the refinery sector.

It should be noted that the HEIDI II model contains considerable uncertainties in the data inputs and modeling assumptions that make up the program, and therefore care is advised when comparing health impacts across chemical classes, particularly between cancer, non-cancer effects, and the criteria air contaminants. The rankings rely on rough statistical estimates of predicted incidence rates for a variety of health endpoints of widely differing severity. The statistical models used to calculate priority rankings can provide useful guidance **in relative terms** by comparing estimated health impacts associated with annual emissions at a generic facility and cannot adequately represent absolute estimates of health risk in the exposed populations. The HEIDI II model should therefore be considered by jurisdictions as one of the possible tools in the management of air pollutants released from oil refineries.

---

[a] The Network for Environmental Risk Assessment and Management (NERAM) reserves the intellectual property rights for HEIDI and is responsible for all changes in the program. NERAM is prepared to provide HEIDI for use with the NFPRER, but any changes to the program would have to be done by NERAM on a cost recovery basis. NERAM website: www.neram.ca

## Data Used to Provide the Health Impact Rankings

The HEIDI II tool comprises three modules:

(1) The **Air Exposure Model** uses a U.S. EPA air dispersion computer model (ISC-AERMOD) to estimate ambient concentrations of carcinogenic and non-carcinogenic air toxics and PM in the defined airshed. Refinery emissions data are from Environment Canada's NPRI database (2001). HEIDI II also estimates in a simplified manner the formation of secondary particulate matter from PM precursors ($NO_2$ and $SO_2$) using conversion factors found in the research literature. The air pollutants are assumed to be emitted from a single stack in the centre of the refinery property. It is assumed that each substance is emitted at a default stack height (30 m) at a constant rate over the period of one year. A generic meteorological profile representing the southern Ontario region is used as the default scenario.

(2) The **Health Effects Module** estimates cancer incidence and mortality, systemic disease incidence and mortality, irritation, and cardiopulmonary disease incidence and mortality associated with the refinery's contribution to the ambient air concentration of each substance. Health effects are estimated within 5 radial zones in a 25 km boundary surrounding a facility considering the predominant wind pattern. This module uses Geographical Information System (GIS) software ARCinfo to determine the exposed population at risk, incorporating population density profiles, Statistics Canada Census Data, baseline mortality and morbidity data from Statistics Canada and the Canadian Cancer Society. This module also considers Environment Canada data on background air levels of pollutants from anthropogenic and natural sources collected in the vicinity of each of the refineries, to estimate the facilities' attributable contribution to ambient air concentrations above background levels at each location. For estimating population health effects of air toxics, HEIDI II uses concentration-response parameter values based on standardized measures of concentration-response derived from Health Canada source materials, or where Health Canada values are not available, from U.S. EPA or CalEPA sources. HEIDI II estimates chronic health effects associated with exposure to particulate matter (PM) based on the extensively peer-reviewed American Cancer Society and Harvard Six City chronic epidemiology studies. The population health impacts associated with chronic exposure to PM are estimated to be as large as or greater than those from acute exposure. It is recognized, however, that HEIDI will likely underestimate the health effects associated with acute (daily) PM exposure to some extent.

(3) The **Health Impacts Module** aggregates diverse health effects of varying severity using a common metric. A series of simplified Disability Adjusted Life Years (DALYs) are calculated based on the approach developed by the International Life Sciences Institute (ILSI), which accounts for three basic levels of severity: (1) irreversible/life shortening; (2) may be reversible, could be life shortening; and (3) generally reversible, generally not life shortening. Another more complex DALY scheme is also used, based on the World Health Organization "global burden of disease" approach for 140 illness categories representing fatal and non-fatal outcomes according to age, sex and other demographic factors. The final output of the HEIDI II package is a priority ranking of those modelled NPRI substances for emissions

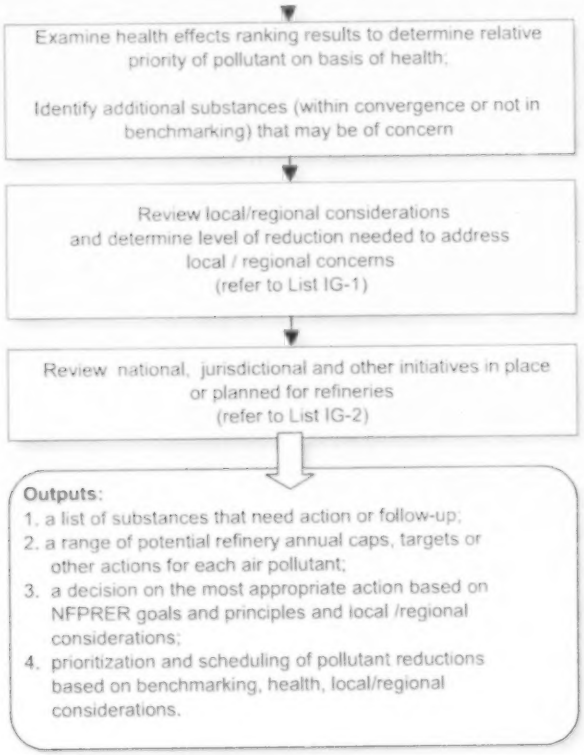
reduction, according to the predicted health effects incidence rates (which do not consider severity) or the predicted health impacts expressed as DALY statistics (which attempt to take age of onset and severity of the health effect into account).

### Recommendations

Given that HEIDI II can produce a relative ranking that is a value in managing emission reductions, the NFPRER Health Prioritization Sub-Group has made the following recommendations:

1. that jurisdictions agree to support the inclusion of the HEIDI II model as a tool under the health prioritization component of the Framework, and consider its output; and
2. as part of the Ten Year Plan, that jurisdictions be encouraged to explore the assumptions inherent in the HEIDI II model, further assess its potential, and be prepared to provide feedback on its value and suggestions for improvement.

### Illustrative Guide


Examine health effects ranking results to determine relative priority of pollutant on basis of health;
Identify additional substances (within convergence or not in benchmarking) that may be of concern
Review local/regional considerations and determine level of reduction needed to address local / regional concerns (refer to List IG-1)
Review national, jurisdictional and other initiatives in place or planned for refineries (refer to List IG-2)
Outputs:
1. a list of substances that need action or follow-up;
2. a range of potential refinery annual caps, targets or other actions for each air pollutant;
3. a decision on the most appropriate action based on NFPRER goals and principles and local /regional considerations;
4. prioritization and scheduling of pollutant reductions based on benchmarking, health, local/regional considerations.

**List IG-1**

Local/regional considerations include, but are not limited to:

- localized health issues;
- community health studies and public health risk assessments;
- regional airshed issues, e.g. ground-level ozone, secondary particulate, smog, visibility;
- local air quality issues, such as odour, nuisance, zoning, siting, dispersion;
- adjacent or contributing sources of pollution;
- transport of pollutants from other areas;
- ambient air quality monitoring data;
- acid deposition;
- other emission reduction or management initiatives already in place or planned;
- economic considerations such as cost-effectiveness and competitiveness;
- local stakeholder concerns and input.

**List IG-2**

International, national and regional initiatives in place or planned include, but are not limited to:

- Canada-wide Standards for Particulate Matter and Ozone;
- Canada-wide Standards for Benzene;
- Canada-wide Acid Rain Strategy;
- Canada-United States Air Quality Agreement; and
- Canada-United States Ozone Annex to the Air Quality Agreement;
- commitments of the Conference of New England Governors and Eastern Canadian Premiers;
- Climate Change Plan for Canada and Large Final Emitters Group of Natural Resources Canada;
- regulations and future requirements respecting sulphur in gasoline, diesel fuel, off-road diesel fuel and light and heavy heating oils.

## Appendix E:

## Emission Monitoring and Reporting Strategy

### Introduction

The Emission Monitoring and Reporting (EM&R) Strategy is the second element in the set of the National Framework for Petroleum Refinery Emission Reductions (NFPRER) deliverables. The strategy was developed under the guidance of the NFPRER M&R Team using a consultative process involving provincial and local government, industry and non-government organizations (NGO) representatives. The strategy is intended to achieve the following objectives:

- appropriate monitoring (measurement or estimation) of emission sources from Canadian petroleum refineries; and
- consistent and effective emissions reporting to local, provincial and federal authorities as well as to the public.

The primary goal of the strategy is to provide guidance and tools for refineries to monitor and report emissions of air pollutants and toxics in a manner that will allow jurisdictions to determine whether annual facility-wide emission limits (caps) are being achieved. Jurisdictions may adapt the EM&R Strategy if they are implementing instruments other than caps to reduce emissions of air pollutants.

### Scope

The following pollutants are addressed in the Emission Monitoring and Reporting Strategy:

- sulphur oxides (SOx);
- nitrogen oxides (NOx);
- volatile organic compounds (VOC);
- carbon monoxide (CO);
- particulate matter (total PM, direct $PM_{10}$, direct $PM_{2.5}$); and
- benzene.

### Refinery and Terminal Definitions

For the purposes of the strategy, a refinery is described as per the National Pollutant Release Inventory (NPRI) definition of a contiguous facility: "all buildings, equipment, structures and stationary items that are located on a single site or on contiguous or adjacent sites and that are owned or operated by the same person and that function as a single integrated site." Emissions from terminals associated with refineries are reported independent of the refinery. A refinery does not include terminal operations, which are defined separately under NPRI.

As per NPRI, terminal operations would include:

(i) the use of storage tanks and associated equipment at a site used to store or transfer crude oil, artificial crude or intermediates of fuel products into or out of a pipeline; or

(ii) operating activities of a primary distribution installation normally equipped with floating roof tanks that receives gasoline by pipeline, railcar, marine vessel or directly from a refinery.

Activities that take place on a refinery site under the NPRI definition, that do not fall under the NPRI definition of a terminal, are included as part of the refinery definition.

### Principles of EM&R Strategy[7]

To meet the outlined objectives, the M&R Team adopted a set of principles to guide their decision-making process. The principles developed for the World Business Council for Sustainable Development for Greenhouse Gases were adapted to apply to monitoring and reporting of air pollutants from refineries in Canada.

- **Relevance** – Define boundaries that appropriately reflect the air emissions of the refinery and the decision-making and verification needs of users of the data.
- **Completeness** – Account for all emission sources of the listed pollutants. Any exclusions should be stated and justified.
- **Consistency** – Consistent methodologies for measurement or estimation should be used to allow meaningful comparison of emissions over time and between facilities. Any changes to the data or methods should be documented.
- **Transparency** – Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Assumptions should be clearly identified and verifiable and appropriate references made to methodologies and data sources used.
- **Accuracy** – Ensure that estimates of air emissions are systematically neither over or under true estimation, as far as can be judged, and that uncertainties are reduced as far as practicable. Sufficient accuracy and precision shall be achieved to enable users to make decisions with reasonable assurance as to the integrity of the reported air emission information.

### Background

To develop the strategy, the M&R Team used the following approach:

- Each pollutant was examined to determine the sources of these pollutants at each refinery.
- Existing emission estimating and/or measuring approaches for each pollutant were summarized.
- Using a set of criteria, minimum acceptable approaches to emission estimation or measurement were identified.
- QA/QC requirements, record keeping, and reporting requirements that are currently used in Canada were examined.
- The current status and methods of ambient air quality monitoring in Canada were examined.
- Recommendations were made on all of these elements to form the EM&R Strategy for the NFPRER.

Technical details of the background and supporting information are provided separately, in the document "EM&R Strategy – Summary and Background."

---

[7] Modified from the Greenhouse Gas Protocol, World Business Council for Sustainable Development, 2001: www.ghgprotocol.org/standard/ghg.pdf

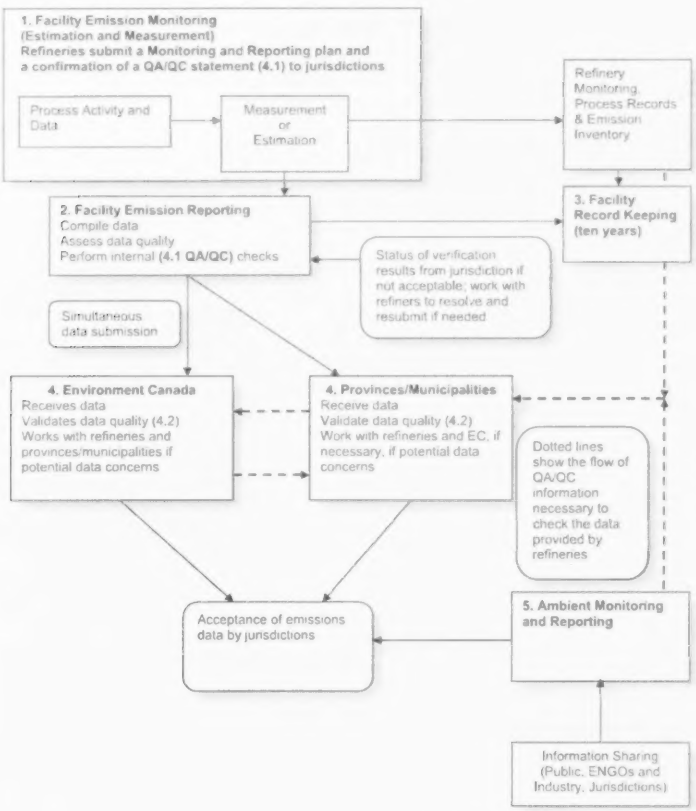
## Elements of the Emission Monitoring and Reporting Strategy

From the compilation of background information, elements of the EM&R Strategy that address the identified principles were assessed. In order to achieve the overall goals of the NFPRER and address the principles set out for the EM&R Strategy, elements of an EM&R Strategy are listed below:

1. Facility Emission Monitoring (Measurement and/or Estimation)
2. Facility Emission Reporting
3. Record Keeping for Facility Emission Monitoring and Reporting
4. Quality Assurance and Quality Control
5. Ambient Monitoring and Reporting
6. Implementation

The following chart (Figure E-1) shows each of these elements and how information would be processed, from refinery monitoring through one-window report submission, the data checking (QA/QC) process, to a final database and reports that would be publicly accessible. Each of the major elements is identified by number and is described in further detail in the following sections.

**Figure E-1 Emission Monitoring and Reporting Elements**


1. Facility Emission Monitoring
(Estimation and Measurement)
Refineries submit a Monitoring and Reporting plan and
a confirmation of a QA/QC statement (4.1) to jurisdictions
Process Activity and Data
Measurement or Estimation
Refinery Monitoring, Process Records & Emission Inventory
2. Facility Emission Reporting
Compile data
Assess data quality
Perform internal (4.1 QA/QC) checks
3. Facility Record Keeping (ten years)
Status of verification results from jurisdiction if not acceptable; work with refiners to resolve and resubmit if needed
Simultaneous data submission
4. Environment Canada
Receives data
Validates data quality (4.2)
Works with refineries and provinces/municipalities if potential data concerns
4. Provinces/Municipalities
Receive data
Validate data quality (4.2)
Work with refineries and EC, if necessary, if potential data concerns
Dotted lines show the flow of QA/QC information necessary to check the data provided by refineries
Acceptance of emissions data by jurisdictions
5. Ambient Monitoring and Reporting
Information Sharing (Public, ENGOs and Industry, Jurisdictions)

## 1. Facility Emission Monitoring (Measurement and/or Estimation)

The M&R Team reviewed a range of monitoring methods used for measurement or estimating emissions from sources or groups of sources at refineries in order to establish compliance with annual, facility-wide emission caps. Source emission estimation and monitoring methods can include the following:

- published emission factors which allow the estimation of emissions based on some other more readily measured parameter at the refinery, such as the amount of fuel burned or the amount of crude processed. The United States Environmental Protection Agency (U.S. EPA) is a key source of emission factor information;
- a range of methods for estimating "fugitive" VOC emissions (those which result from leaks from valves, connectors, pumps and other process equipment) including emission factors, portable monitoring devices and mathematical correlations to predict emissions;
- source testing stack surveys, which provide a discrete "snapshot" of emissions during a specified test period. The operating conditions during the test period should be representative of normal operating conditions if used to estimate annual emissions;
- mass balance calculations, which estimate emissions based on information about the amount of material going into a process, and the physical or chemical changes it may undergo in the process;
- emission models, such as the U.S. EPA TANKs software, which requires the user to enter detailed information about storage tank types (physical characteristics, associated fittings, tank seals, etc.), the material being stored and the atmospheric conditions, allowing the model to generate an estimate of the emissions from the storage tank;
- predictive (or parametric) emission monitoring (PEM), which uses the measurement of process parameters, like combustion zone temperature or steam production rate, and a knowledge of the relationship between emissions and these process parameters, to estimate emissions; and
- continuous emission monitors or CEMs, which monitor the concentration of an air pollutant from a release source on a continuous basis (i.e. the frequency of data recording varies, but the instrument is in use 24 hours per day).

The M&R Team, in its evaluation of methods, reviewed factors such as the pollutant of interest; the characteristics, significance and variability of the emission source; precision and accuracy of the methods (method uncertainty); equipment reliability; and cost and complexity. Consideration was given to allow some flexibility to accommodate for unique refinery configurations where some methods may not be practical or appropriate. From the suite of options focusing on the need to establish compliance with annual facility-wide emissions caps, the M&R Team selected one method or several acceptable options for monitoring emission sources for each pollutant and source.

Facility emission monitoring should be implemented as follows:

1.1 Refineries must account for all emissions sources of the listed pollutants. Any exclusions should be clearly stated and justified. This includes emissions from all parts of the facility as defined by NPRI. Any exceptions must be documented, and the emissions resulting from the sources added to or not included in the NPRI facility definition should be documented.

1.2 Total actual annual emissions must be measured or estimated, including emissions occurring during both normal operating conditions and abnormal conditions (e.g. start-up, upsets, and maintenance turnarounds).

1.3 For the sources outlined in Table E-1, the emissions should be monitored using the recommended method, or another method of comparable or better accuracy for determination of emissions on an annual basis, if approved or specified by the regulating jurisdiction. Where options are given, refineries and jurisdictions should consider the unique refinery configuration, and the full range of emissions monitoring needs in selecting the recommended monitoring method. Some jurisdictions may require alternative monitoring methods.

1.4 Prior to implementation of the strategy, each refinery should submit a proposed plan for an Emission Monitoring and Reporting Strategy for consideration and acceptance by the jurisdiction having authority. This plan could include a confirmation of a QA/QC statement (4.1), methodologies, verification steps for emission factors and any other elements for which jurisdictional approval has been identified.

1.5 Innovative methods or technology that become available in the future should be accommodated and reviewed through the NFPRER.

## Table E-1: Recommended Methods to Establish Annual Refinery Emission Levels

| Substance | Source | Method |
|---|---|---|
| NOx | Fluid catalytic cracking units | Emission factor (with verification) [Note 1] |
| | | Continuous emission monitor |
| | Sulphur plant | Emission factor (with verification) [Note 1] |
| | Boilers and heaters | Capacity [Notes 2 and 3]:<br>>250 MMBtu/hr – Annual stack survey plus continuous verification<br>100-250 MMBtu/hr – Annual stack survey<br><100 MMBtu/hr – AP-42 emission factor |
| | Flares | Emission factor |
| $SO_2$ | Fluid catalytic cracking units | Emission factor (with verification) [Note 1] |
| | | Continuous emission monitor |
| | Sulphur plant | Mass balance |
| | | Continuous emission monitor |
| | Boilers and heaters (solid and liquid fuels) | Mass balance |
| | Flares | Emission factor |
| CO | Fluid catalytic cracking units | Emission factor |
| | | Continuous emission monitor |
| | Boilers and heaters | Emission factor |
| | Flares | Emission factor |
| Particulate matter | Fluid catalytic cracking units | Emission factor (with verification) [Note 1] |
| | | Mass balance – measured catalyst losses |
| | Boilers and heaters (solid and liquid fuels) | Emission factor (with verification) [Note 1] |
| | Boilers and heaters (gaseous fuels) | Emission factor |
| | Flares | Emission factor |
| VOC/ Benzene | Fugitive | CCME fugitive VOC Code Monitoring Section [Note 4] – EPA leak rate/screening value Correlation equations. Emission factors or Stratified Emission Factors for flanges |
| | Storage tanks | Emission model – U.S. EPA Tanks Program |
| | Loading | Emission factor – Canadian Petroleum Products Institute (CPPI) Code of Practice [Note 5] |
| | Wastewater | |
| | Landfarms | |
| | Non-routine | |
| | Boilers and heaters | Emission factor – AP-42 |
| | Flares | |

### Note 1 (with verification)

It is suggested that each refinery and jurisdiction consider a number of elements to evaluate the appropriateness of a selected emission factor for each of these sources. This could include, but is not limited to, one or a combination of the following:

- For emission factors, reviewing the background information to see if the factor is applicable to the refinery of interest.
- Assessing the potential differences between the unit/process of interest and the selected emission factor.
- Comparing representative compliance stack surveys of the reporting year to the emission factor.
- Comparing emissions reported to the jurisdiction from other similar sources with the estimated values using emission factor(s).
- For steady continuous sources, the potential use of stack survey as a replacement for the emission factor.
- Using stack surveys to confirm that the emission factor accurately represents the emissions from the particular unit in question.
- Using additional stack surveys or supporting information from the refinery to support the use of the emission factor.
- Developing a site-specific emission factor if supported by other emission measurements.
- If operating conditions change, or at least once every five years, performing verification by stack survey.

Stack survey verification is not required where stack surveys cannot be performed because of safety limitations (inability to install platforms, sources too close together) or configurations that will not provide representative results (bends/expansions close to exit point).

### Note 2

*National Emission Guidelines for Commercial/Industrial Boilers and Heaters, Initiative N306, CCME,* March 1998 – PN1286. Continuous verification could include continuous emission monitoring, process capability methods, surrogate methods and parametric methods.

### Note 3

Current CPPI interpretation on adoption of N306 says that annual verification is only needed in cases where combustion conditions or design has changed.

### Note 4

*Environmental Code of Practice for the Measurement and Control of Fugitive Emissions from Equipment Leaks, CCME,* October 1993 – PN1106
(Appendix D – p. 22, EPA Leak Rate/Screening Value Correlation Equations
and EPA-453/R-95-017, p. 2-27).

### Note 5

The CPPI *Code of Practice for Developing an Emission Inventory for Refineries and Terminals*, updated December 2003, which includes some modifications in the manner in which the basic AP-42 emission factors are used that make them more representative of actual refinery conditions.

## 2. Facility Emission Reporting

Regulatory compliance reporting is currently required for all refineries in Canada by their facility permits and approvals, or under provincial or local regulations. National facility-wide emission reporting is required under Environment Canada's National Pollutant Release Inventory (NPRI), which includes all the substances considered by the NFPRER. In order to establish consistency, verifiability and transparency, facility emission reporting should provide:

- availability of source-specific emissions and information on methods and emissions to all jurisdictions for verification and quality control;
- a one-window approach for reporting facility-wide annual emissions; and
- broad availability of quality-assured annual facility-wide emission information to the public and jurisdictions in a timely fashion.

The following elements are identified for emissions reporting:

2.1 Each refinery should report total annual facility-wide air emissions of each pollutant each calendar year from all sources within the refinery;[8]

2.2 Each refinery would report the methodology(ies) used to estimate the emissions by aggregated sources to (an adjusted) NPRI as follows:

- NOx heaters and boilers, FCCU, sulphur plant, flares;
- $SO_2$ heaters and boilers, FCCU, sulphur plant, flares;
- CO heaters and boilers, FCCU, flares;
- PM heaters and boilers, FCCU, flares;
- VOC heaters and boilers, equipment leaks and fugitives, storage/handling, wastewater, process drains.

Where jurisdictions have approved alternative approaches to those identified in Table E-1, this should be noted as the methodology used.

2.3 Each refinery would report supporting facility information (e.g. industrial classification, contact information supporting comments) as set out in the annual notice for NPRI reporting published in the *Canada Gazette*. Other information on methodologies and emissions reported to NPRI – for example, breakdown by spills, stacks and other non-point sources – would remain reportable as per current NPRI requirements.

2.4 Information will be provided to Environment Canada (via an adjusted NPRI) by June 1 of the year following the emissions; data will be supplied concurrently in electronic format to the jurisdiction regulating air emissions from that facility (e.g. provincial or municipal government).

[8] Jurisdictions may impose additional reporting requirements.

2.5 Facilities should retain records as set out under "Record Keeping" (Section 3) for the reported emissions for a ten-year period (implementation period of the NFPRER), as set out by jurisdictions.[9]

2.6 The public and other users of the data will have ready access, in electronic format, before December 31 of the year following the emissions. Information could also be made available in paper format, and from refineries, industry associations or citizens' committees.

### 3. Record Keeping for Facility Emission Monitoring and Reporting

The facility will be responsible to ensure that appropriate records are kept that demonstrate that the methods (or jurisdictional-approved alternatives) outlined in Section 1 were utilized in the emission monitoring.

Records that should be retained for possible future review by jurisdictions include, for each pollutant emission report submitted:

3.1 a list of sources at the facility;

3.2 annual emissions from each source, annual facility-wide emissions, and supporting calculations;

3.3 the specific methodology used, supporting data and confirmation of approval by the province or jurisdiction of alternative monitoring methods, the basis of the emissions estimate for each source, under normal conditions, and non-normal operating conditions, including start-up, upset and maintenance turnaround conditions, etc. This information could include:

- CEMS – information on the instrument, procedures followed, and measured emissions;
- PEMS – the parameters and quantities used in the estimate;
- source tests – summary of the conditions and methods used in the tests frequency;
- mass balance – the measured input into the system, output of the system, frequency of sampling;
- emission factor – both the emission factor used and the base quantity or operating parameter applied to the factor; the frequency of measurement of the base quantity;
- correlation equations and stratified factors – equipment and type of service; component counts of valves, pressure release valves, pump seals, compressor seals, open-ended lines, connectors and flanges; sources of data used to derive component counts; estimates and assumptions for inaccessible components; screening values, and equations used to derive fugitive VOC estimates;

[9] The current NPRI record-keeping period is three years.

3.4 facility data quality assurance/quality control mechanisms used (see Section 4); and

3.5 other data, if alternative methods or specific refinery configurations require them.

To support the ten-year implementation time frame of the NFPRER, each facility should keep records for a ten-year period.

## 4. Quality Assurance and Quality Control

Quality assurance and quality control of emission data are needed to ensure that the principles of the Emission Monitoring and Reporting Strategy are met.

### 4.1 QA/QC for Facilities

4.1.1 The quality control procedures should include steps to ensure that the emission measurement or estimation method is performed as described in the applicable methodology. This requires that the correct methodology and equipment be available at the facility as well as people who are qualified in its use. Records shall be kept demonstrating that the correct procedures were followed.

4.1.2 If alternative methods for monitoring are used, they should be documented and reasons for use provided.

4.1.3 Facilities should document any procedure changes to the recommended methodology and incorporate them into their QA/QC program.

4.1.4 Emission values and trends should be examined each year on an individual source basis, and internal verification processes should be initiated where unexplained changes occur.

### 4.2 Data Quality Validation (QA/QC) for Provinces, Municipalities and Environment Canada

As outlined below, it is intended that verification would consist of a combination of quantitative and qualitative approaches used by provinces, municipalities and Environment Canada, that would be conducted either complementary with or in addition to their current requirements. The level of quantitative review will depend on current practices, details involved in the review from year to year, and changes that could occur at the refinery.

4.2.1 For the first review of facility annual emissions, provinces and municipalities should conduct data quality validation and examine records outlined in Section 3 thoroughly and ensure that the acceptable method has been used (e.g. specific attention to how short-term events are incorporated could be examined).

Provinces and municipalities are encouraged to work jointly with Environment Canada to address shared concerns and ensure coordinated data quality validation and information sharing when needed.

4.2.2 The following questions could help guide the process:

- CEMS – Is there a QA/QC program? Does it meet the regulatory compliance (if applicable)?
- PEMS – What are the parameters and quantities used in the estimate?
- Mass balance – Is it consistent with the prescribed regulatory process? What is the frequency of the mass balance measurements? Is it statistically representative?
- Emission factor – Does the type of factor match the unit of interest? What base quantities are used and how are they used? Is the factor within the AP-42 range? What method of verification was selected (Section 1) and is it appropriate?
- Source tests – Summary of the conditions and methods used in the tests, including frequency, representativeness of conditions. If source test were used in verification, is documentation available? Does the test adequately account for variability in the source?
- Correlation equations and stratified factors – How were components estimated? What assumptions were used to estimate inaccessible components? Were any sampling locations for equipment and service type suitable?

4.2.3 For subsequent years, jurisdictions could continue to check and review, with specific focus on significant changes of emissions and/or processes that may have occurred at the facility. If there are changes (i.e. >10% without facility-supplied comments explaining reasoning), records/back-up on changes should be reviewed through dialogue or information exchange with the refinery.

4.2.4 Jurisdictions would review the provided information and request further information from facilities, if deemed necessary, in order to finalize data validation by October 31 of the year following the emissions.

## 5. Ambient Monitoring and Reporting

An assessment of the current level and manner of ambient air quality monitoring was conducted. Since ambient monitoring is primarily used to address specific local, regional and airshed issues, it is a jurisdictional matter. Thus, ambient monitoring and reporting are not the focus of the Emission Monitoring and Reporting Strategy; however, some recommendations were identified.

5.1 To address ambient monitoring needs, individual jurisdictions, ENGOs and industry should consider establishing local stakeholder groups where these groups do not exist.

5.2 Jurisdictions, industry and other stakeholders should share information on approaches, data quality, public participation, formats, distribution, consistency and accessibility.

5.3 Jurisdictions could use the NFPRER health prioritization tool to assist in selecting new substances to be monitored.

5.4 It is recommended that at a minimum, ambient monitoring be conducted in the vicinity of each refinery. (There was no agreement on pollutants.)

5.5 Ambient monitoring alone does not provide sufficient information to assess whether emission reductions from a refinery are being achieved, and should not be used as a basis to evaluate the success of the NFPRER. However, stakeholders should consider including ambient monitoring data in periodic reporting to the Framework, in cases where refinery emission reductions can be linked to the data trends.

5.6 As part of the periodic reporting under the Ten Year Plan, jurisdictions are encouraged to summarize their practices used (if applicable):

- characterizing the emissions (both anthropogenic and natural) in the airshed that contribute to air quality;
- characterizing the meteorology of the airshed;
- conducting dispersion modelling to determine the magnitude, the frequency and the relative contribution of the emissions to receiving areas;
- prioritizing the air quality issues for the airshed of concern;
- determining monitoring requirements to address the priorities;
- identifying placement of and implementing ambient monitoring according to defined criteria that address the air quality priorities identified.

## 6. Implementation

In order to implement the EM&R Strategy and ensure that all of the pertinent information is available for tracking progress and reporting in the Framework, action may be required by refineries, jurisdictions and Environment Canada. The requirement and accountable party is outlined for each element identified in the strategy.

### Facility Emission Monitoring (Measurement and/or Estimation)

6.1 Assess additional requirements and equipment to estimate emissions according to the identified methodology – Refineries

6.2 Make appropriate emission estimation, monitoring or verification changes – Refineries

6.3 Implement changes to the "CPPI Code of Practice for Developing an Emission Inventory for Refineries and Terminals" to reflect all elements of the Emission Monitoring and Reporting Strategy – CPPI and its member refineries. Implement changes to procedures for other refineries to reflect all elements of the Emission Monitoring and Reporting Strategy – Other refineries

6.4 Determine whether a proposed alternative methodology is necessary/acceptable/required – Jurisdictions/Refineries

6.5 Make adjustments to permits to reflect the Emission Monitoring and Reporting Strategy – Jurisdictions

### Facility Emission Reporting

6.6 Make the additional changes to NPRI reporting software elements. Provide a mechanism to identify alternative approaches if they are selected by jurisdictions – Environment Canada

6.7 Make final data available (electronically or in print) to the public by December 31 – Environment Canada

6.8 Emissions related to processing by and for a third party should be identified and arrangements made to include in reporting – Jurisdictions and Refineries (e.g. off-site sulphur plant)

### Record Keeping for Facility Emission Monitoring and Reporting

6.9 Make adjustments to account for a ten-year period of record holding and whether additional records are required – Refineries and Jurisdictions

### Quality Assurance and Quality Control

6.10 Make adjustments to internal QA/QC procedure – Refineries

6.11 Determine any adjustments to data requests or permit requirements that may be made to refineries – Jurisdictions

6.12 Summarize procedures and information to establish acceptance of the reported emissions – Jurisdictions

### Ambient Monitoring and Reporting

6.13 Determine if ambient monitoring identified in strategy is being conducted in the vicinity of the refineries and facilitate public accessibility to the data – Jurisdictions/Refineries

6.14 Consider establishing collaborative local groups (if none exist) to discuss ambient monitoring needs, priorities, emission estimation alternatives, etc. – Refineries/ENGOS/ Others

### Timeline for Implementation

6.15 While implementation of the overall Framework may occur on different schedules at different refineries, dependent on permit renewals or management instrument development, most elements of the EM&R Strategy should be implemented beginning with the 2005 reporting year. Where significant investments in equipment are required, provinces and municipalities should work with refineries to determine an acceptable schedule for EM&R Strategy implementation.

## Appendix F: Ten Year Plan

### Table F-1: Reporting on Current Practices

| Current practices employed by jurisdictions | Recommended elements |
|---|---|
| Design of regulatory and other instruments for refineries (or other industrial sectors or sources) | • Programs in place or under development<br>• Emission standards:<br>  • Point of impingement<br>  • Concentration<br>  • Caps<br>• Compliance and enforcement<br>• Other instruments used:<br>  • Emission trading<br>  • Economic instruments |
| Monitoring and reporting requirements | • Facility level<br>• Source level<br>• Ambient air quality monitoring |
| Health | • Health effects studies<br>• Health risk assessment<br>• Indicators of health impacts<br>• Health considerations in the regulatory process |
| Public and stakeholder involvement | • Public review processes with respect to:<br>  • Policy and regulation development<br>  • Applications and amendments for permits, certificates of approval, etc.<br>• Role of community advisory panels<br>• Reporting to the public on health and environmental issues related to refineries |